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[G-1] Niagara peninsula conservation report, 1952



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Two young girls enjoy the summer sun at Long Beach Conservation Area. Behind them, to the left, is the picnic area and to the right, the day-use beach.

Department of the Environment

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— N. D. PATRICK, Director, Conservation Authorities Branch —

— **niagara** —

— **peninsula** —

— **conservation** —

— **report** —

1972

— **volume I** —



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Conservation Authorities Branch
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[G-1]

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PART ONE

SUMMARY AND INTRODUCTION

SUMMARY

The Niagara Peninsula Conservation Authority has jurisdiction over an area of 936 square miles traversed in an east-west direction by the Niagara Escarpment. Most of the area is a plateau at an elevation of about 600 feet above sea level extending south from the escarpment to Lake Erie. The narrow strip below the escarpment and fronting on Lake Ontario is at an elevation of about 300 feet. The climate is greatly modified by the lakes and the protection of the escarpment.

The relatively flat plains below the escarpment have soils and climate suitable for soft fruit production. Above the escarpment soils and topography are more varied including till moraines, clay plains and sand plains. Limestone quarries, gravel pits and clay pits for brick and tile are common features. In general, the soils of the area show sufficient capability for agriculture so that only wetlands, a few rough hilly areas and the escarpment have remained as forest or prime wildlife areas.

Most of the streams are relatively small watercourses draining into Lake Erie, Niagara River or Lake Ontario. The threat of floods is limited but control of bank erosion and pollution and the assurance of sufficient flow in dry periods all present problems.

The area is capable of additional development for sport fishing, hunting, nature observation and enjoyment of the scenic features of the Niagara Escarpment.

Following permanent settlement after the American Revolution, the contact of the Niagara Peninsula with the United States became an important factor in the development. Development of the Welland Canal and hydro-electric power encouraged the growth of industries. Fruit growing was important from an early stage, specialization in tender fruits and grape growing developing later and continuing to increase until recent years when urban growth limited further expansion. From the early 19th century, the falls at Niagara have attracted tourists in increasing numbers up to the present time.

Recent intensification of agriculture has been mainly in vineyards and more concentrated livestock and poultry production. Even where woodland remains, the grazing of woodlots and the resulting poor regeneration has decreased the productivity of the forest.

Improper field cultivation practices and the lack of vegetative cover on sloping vineyards contributed to erosion, losses of soil with consequent muddying of streams and siltation of reservoirs. Tile drainage outlets need protection from erosion and grass waterways are recommended in a number of locations.

The principal sources of pollution are identified and the Authority is advised to co-operate with the Ontario Water Resources Commission in monitoring its streams and in educating the public to avoid practices which contribute to water pollution. Mention is made of other factors which impair the environment and the need for education, planning and controls to reduce this impairment.

Several projects for providing increased streamflow are recommended for further investigation. Installation of improved farm ponds is advocated.

Demonstrations and education are suggested to reduce erosion through better land use by contour tillage, use of windbreaks, establishment of grass waterways, exclusion of cattle from eroding stream banks. Protection of drainage tile outlets is advocated.

Hazard Lands have been mapped and these should be included in municipal zoning and official plans.

Eleven wildlife areas are recommended for private improvement or public acquisition. The Authority is urged to encourage persons owning suitable habitat to install Wood Duck nesting boxes and those owning fishing streams to open them to public fishing on a fee basis. The Authority should urge its municipalities to preserve wildlife habitat by restricting roadside spraying to those areas where the need is established.

Recommendations are made for careful long-range planning to produce a high quality environment for recreation and a conservation area classification and zoning plan is described. Thirteen potential conservation areas are described briefly for the Authority's consideration. Two hiking trails and a scenic drive are outlined. Stress is laid on the need for liaison and integration of Authority recreational developments with those of other agencies to produce a co-ordinated regional recreation program.

Part 6 of the report outlines the form and suggests some of the contents of a Conservation Plan designed to clarify Authority policy and provide a basis for orderly implementation of measures to ensure maximum benefits to society from the natural resources of the Niagara Peninsula. Co-operation with other governmental bodies is stressed and it is suggested that a realistic ceiling, based on provincial equalized assessment, be established for the general levy on member municipalities.

Establishment has been suggested of a set of development priorities for a five-year period, to be considered as part of a broader, long-range program. The priorities would be adjusted from time to time as conditions warrant and a complete review will be made after the first five-year period. Many of the programs are of a continuing nature, not necessarily costly, but requiring an early start and continued vigorous promotion. In the more specific projects stress is placed on early acquisition of the lands required for later development.

The implementation of the Plan will depend on the enthusiastic co-operation, financial and otherwise, of the participating municipalities, the members of the Authority and the private citizens of the Niagara Peninsula.

INTRODUCTION

The Niagara Peninsula Conservation Authority was established on April 30, 1959, by Order-in-Council 1383/59 and its boundaries altered slightly in 1967 by OC 1033/67. The present area of jurisdiction of the Authority covers the watersheds of:

- a. all rivers entering Lake Ontario between the east boundary of the watershed of Fifty Mile Creek and the Niagara River.
- b. all rivers entering the Canadian side of the Niagara River and
- c. all rivers entering Lake Erie between the Niagara River and the east boundary of the watershed of the Grand River.

At the request of the Authority, a partial survey of the recreational aspects of the peninsula was carried out in the summer of 1959, and a report issued to the Authority in 1960. Again in 1961 and 1962, the water problems of some of the streams in the area were investigated and a report issued to the Authority in 1964.

In 1970, the Conservation Authorities Branch of the Department of the Environment, carried out a more comprehensive survey which is the basis of the current report. At the beginning of the survey, contact was made with such sources of existing information as the Ontario Department of Agriculture and Food, the Department of Lands and Forests, the Ontario Water Resources Commission and the Niagara Parks Commission. Field studies were designed to enlarge and fill gaps on this information. The studies covered conservation aspects of land, forest, water, wildlife, recreation and community planning. Survey crews consisted of university students in these subjects under the direction of the experienced section heads of the Conservation Authorities Branch.

Conditions reported are, of course, those at the time of survey in 1970 and may, in some instances, have changed even in the short time that has lapsed since the survey was completed.

The report is primarily for the guidance of the Niagara Peninsula Conservation Authority in formulating and carrying out the program of conservation in its area of jurisdiction. The implications of the report are, however, considerably broader. It should provide additional guidance to other agents, government or private, concerned with management of resources in the region and to municipalities in their planning for orderly development of rural and urban areas. Above all, it is hoped that this report will promote a co-ordination of effort by all agencies to achieve a program of maximum effectiveness for the people of the Niagara Peninsula.

Volume I, Conservation Report and Plan, while in itself a working document for the Authority, is of general interest to all who concern themselves with conservation in the peninsula. It has been printed in sufficient quantity to allow for public distribution.

Volume II, Appendix, contains additional technical material including maps and charts, primarily of concern only to those responsible for making decisions on a conservation program. It is printed in limited quantities for Authority members and other persons involved. It is hoped at a later date to issue a companion volume, History, to give the background of resources development in the area.

Acknowledgements

Appreciation is expressed for the assistance in the survey and preparation of this report received from members of the Authority, other residents of the Niagara region, and from the staffs of the following:

The Regional Municipality of Niagara

Niagara Parks Commission

The St. Lawrence Seaway Authority

Department of Geography, Brock University

Ontario Department of Health

Community Planning Branch, Ontario Department of Municipal Affairs

Ontario Water Resources Commission.

PART TWO

NATURAL RESOURCES OF THE AREA

Section 1

LOCATION

The Niagara Peninsula Conservation Authority, formed by Order-in-Council 1383/59 on April 30, 1959, encompasses all or parts of the following municipalities:

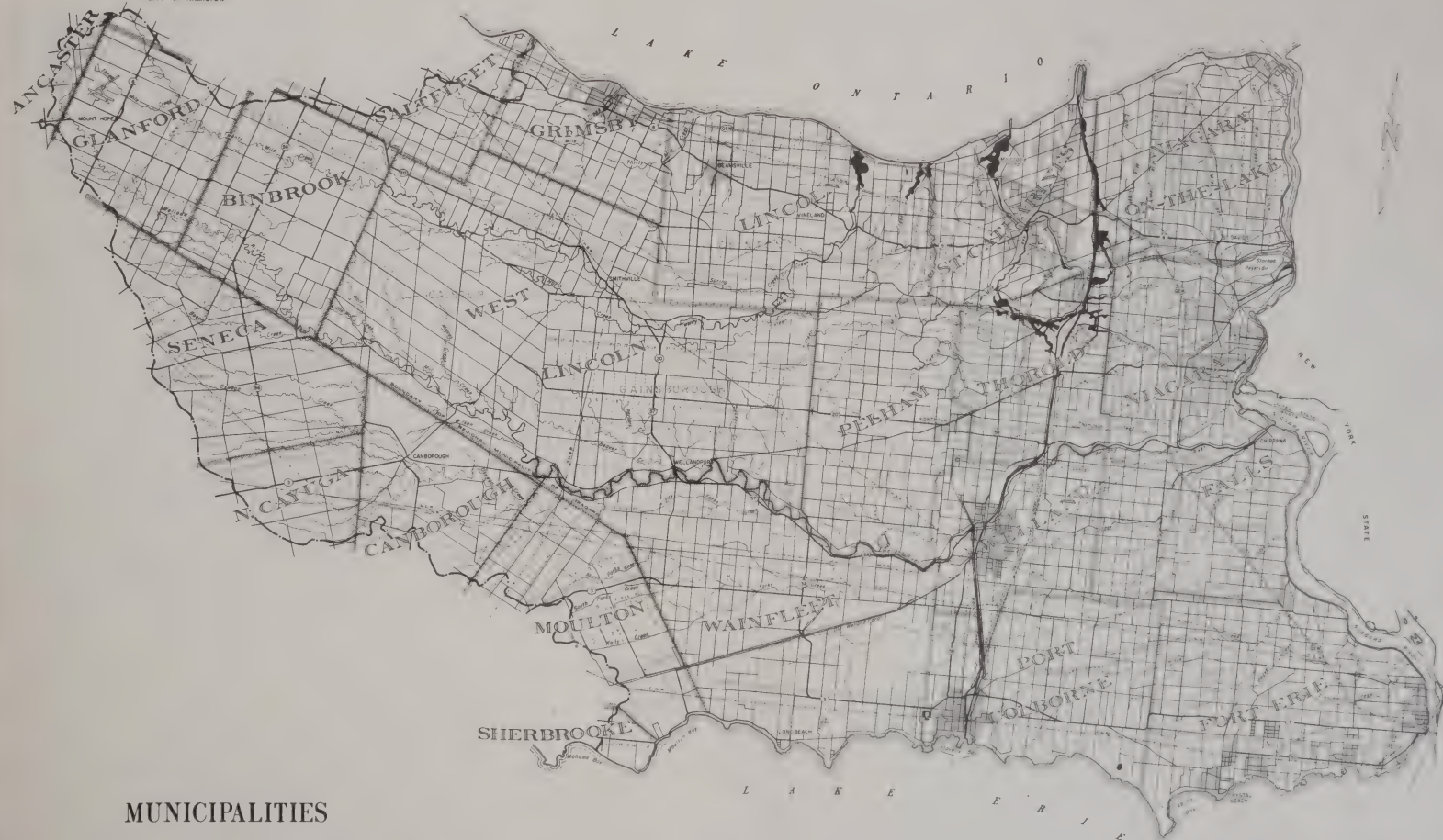
- Township of Ancaster
- Township of Binbrook
- Township of Canborough
- Township of North Cayuga
- Township of Glanford
- Township of Moulton
- Regional Municipality of Niagara
- Township of Saltfleet
- Township of Seneca
- Township of Sherbrooke

All of these are participating municipalities and appoint members to the Authority. The total population is 358,444.

The area under the jurisdiction of the Authority is 936 square miles and comprises the watersheds of all the streams entering Lake Ontario east from Fifty Mile Creek to the Niagara River, all streams entering the Canadian side of the Niagara River and all streams entering Lake Erie from the Niagara River to the east boundary of the Grand River watershed.

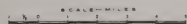
Of the 37 conservation authorities in Ontario, the Niagara Peninsula ranks fourteenth in area of jurisdiction, but fourth in population.

CITY OF HAMILTON



MUNICIPALITIES

FIG. 1-1





Section 2

CLIMATE

The climate* of an area depends on its location within the world-wide circulation of the atmosphere. The influence of this circulation, however, may be modified significantly by physiographic features. In the Niagara region two such features, variations in topography, and proximity to the Great Lakes, are particularly important.

The extensive water surface area of the Great Lakes has a pronounced moderating effect on climate conditions of adjacent land areas — especially so in the Niagara Peninsula which is wedged between Lake Ontario on the north and Lake Erie on the south. This is illustrated in Figure 2-1 which shows the relationship of mean monthly values of precipitation and temperature at Vineland as compared with Chicago, on the western edge of Lake Michigan, and Ottawa, somewhat east of the lakes.

The elevation of the major portion of the region, which is the plateau above the Niagara Escarpment, is about 600 feet above sea level, rising to 800 feet in the western section. However, below the escarpment the average elevation is about 300 feet, sloping gradually to Lake Ontario and 245 feet. This latter section of highly productive land, averaging 4 to 5 miles in width and known as the Niagara Fruit Belt, is particularly suited to growing soft fruits such as peaches, apricots and grapes and also tender ground crops due to the area's moderate temperature regime.

In the fruit belt the recorded extreme low temperatures range from 15 to 20 degrees F. below zero, while above the escarpment, they are in the 20 to 30 degrees F. below zero range. A similar effect is noted in the frost-free period which annually averages 175 days (April 26 to October 20) below the escarpment and 160 days (May 5 to October 13) above.

The following table† of detailed weather data for the weather station at Welland is indicative of the values prevailing in the Niagara region.

The average annual temperature is near 48 degrees F. February, the coldest month, averages 25 degrees F. and July, the warmest, 72 degrees F.

The average annual precipitation over the region (snow being expressed as water equivalent) is about 34 inches, of which the average rainfall is 28 inches and the snowfall about 64 inches.

The precipitation is equitably spread throughout the year with monthly averages ranging from 2 to 3 inches.

The average rainfall for the five-month growing season, from May to September, is about 14 inches.

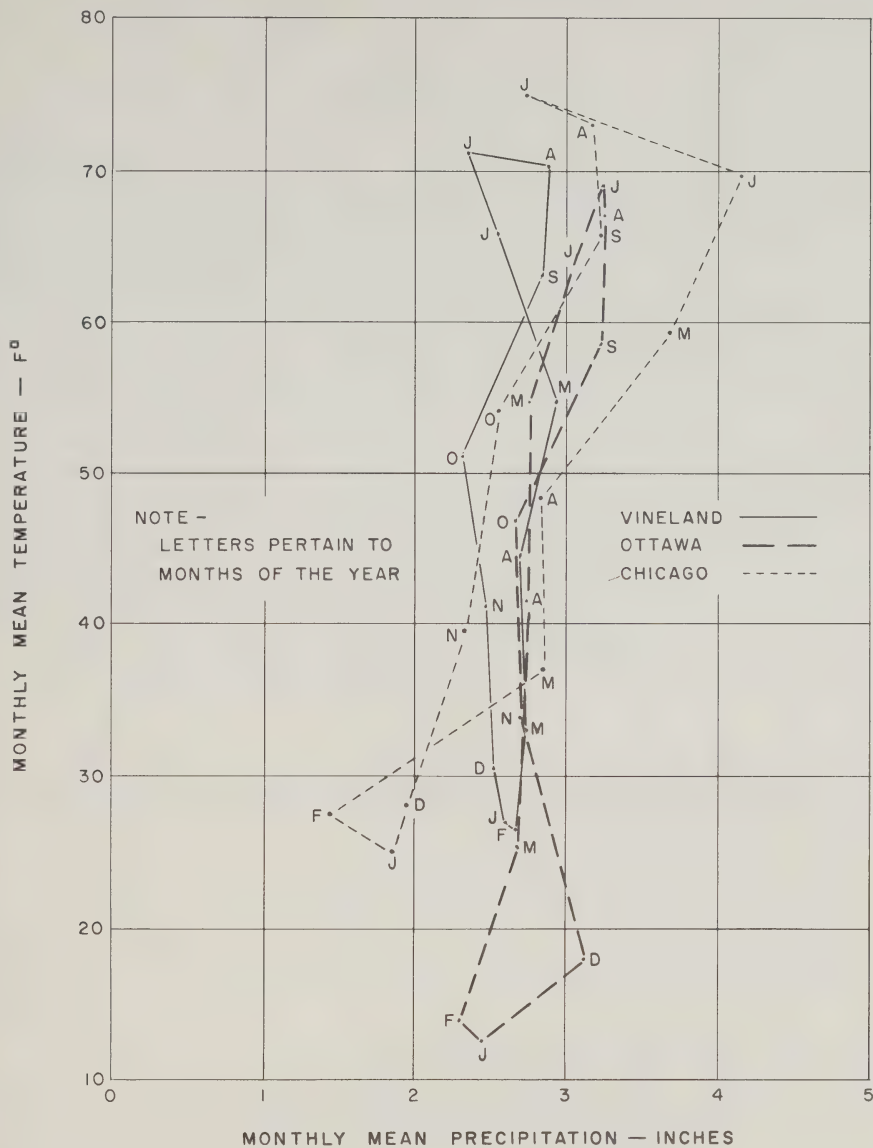
* Brown, D.M., et al, *Climate of Southern Ontario*, Meteorological Branch, Canada Department of Transport, Toronto, Canada, 1968, U.D.C. 551582 (713).

† Temperature and Precipitation Tables for Ontario; Meteorological Branch, Canada Department of Transport, Toronto, Canada, 1967.

Table 2-1: Climate Data — Welland

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Year
				Latitude 43 00 N Longitude 79 16 W Elevation 575 Ft ASL									
Mean Daily Temperature (°F.)	25.6	25.4	32.6	44.6	55.9	66.3	71.6	70.2	62.9	52.2	40.4	29.3	48.1
Mean Daily Maximum Temperature	32.7	33.5	41.0	54.6	67.3	77.8	82.4	80.6	73.4	62.3	48.0	36.1	57.5
Mean Daily Minimum Temperature	18.4	17.2	24.2	34.6	44.4	54.8	60.7	59.8	52.4	42.1	32.8	22.4	38.7
Maximum Temperature	68	65	80	85	93	97	100	100	95	90	78	70	100
Minimum Temperature	-27	-24	-18	-1	21	34	35	37	28	17	-4	-18	-27
Mean Rainfall (inches)	1.59	1.48	1.89	2.57	3.08	2.16	2.54	2.84	3.28	2.81	2.17	1.63	28.04
Mean Snowfall	14.3	15.7	13.8	3.5	0.1	0.0	0.0	0.0	0.0	0.2	6.8	9.4	63.8
Mean Total Precipitation	3.02	3.05	3.27	2.92	3.09	2.16	2.54	2.84	3.28	2.83	2.85	2.57	34.42
No. of Days With Measurable Rain	6	5	7	10	12	9	9	9	9	10	10	7	103
No. of Days With Measurable Snow	12	11	9	2	*				*	*	4	9	47
No. of Days With Meas. Precipitation	17	14	15	12	13	9	9	9	9	10	14	15	146
Maximum Precipitation in 24 Hrs.	1.59	1.83	2.40	1.60	1.88	2.06	4.20	3.47	4.66	2.32	1.19	1.35	4.66

*Occasional Snow



PRECIPITATION-TEMPERATURE GRAPHS

(MEAN MONTHLY DATA)

VINELAND, OTTAWA and CHICAGO

Section 3

GEOLOGY AND PHYSIOGRAPHY

1. Bedrock Geology

Within the Niagara Peninsula Conservation Authority, the Niagara Escarpment, as the dominating feature, divides the area into what can be referred to as the Ontario Uplands and the Ontario Lowlands Section of the much larger region called the St. Lawrence Lowlands. The Ontario Lowland pertains to the shoreline benches below the escarpment.

The bedrock formations are of the Paleozoic Era and are generally flat lying, although these sedimentary rocks do indicate a dip-slope in a southerly direction at approximately 28 feet per mile.* Due to differential weathering and the dip-sloping of the sedimentary rock, a cuesta has developed with a long sloping grade to the south and a steeply sloped bluff on the north side to create the Niagara Escarpment.

The physical features of the Niagara Escarpment are due, for the most part, to Ordovician and Silurian rocks of the Paleozoic Era. Queenston shales of the Ordovician Period are susceptible to weathering and, consequently, erosion along the base of the Niagara Escarpment is quite evident. Reddish clay soils found along the base of the bluffs indicate the rapid breakdown of the Queenston shales. Sandstones, shales, limestones and dolomites of the Silurian Period tend to be more resistant to weathering and thus exert a controlling effect which preserves the elevated feature of the escarpment. In particular the Silurian dolomites provide a hard cap for the escarpment on the upper levels.

During the Pleistocene Epoch, the region was subjected to glacial activity which superimposed varying thicknesses of glacial drift material.

2. Topography

The topography of the Authority area was influenced by varying glacial and interglacial periods, especially the latter during the late stages of the Wisconsin Ice Stage. In fact glacial deposition was more important than glacial displacement in shaping the landscape of the region.

For description purposes, the topography can be divided into two segments, with the beach terraces and the toe of the escarpment forming one segment, while the uplands form the other. The difference in elevation between the two segments is approximately 300 to 350 feet. In a few locations where watercourses have transected the escarpment, the resultant deep V-shaped valleys indicate that these same valleys were not subjected to extensive glacial action.

Below the escarpment prominent beach benches are evident in some locations, while in other locations the terraces slope gently away from the toe of the bluffs. These relatively flat plains are the results of the wave-washing action of the early Lake Iroquois, the forerunner of the present Lake Ontario. The spectacular Niagara Gorge had its early stages of development initiated when Lake Iroquois was having its beginnings. Later in the Lake Iroquois stage, a number of embayments were created and left significant features along the escarpment. Two of the major embayments are evident at Twelve Mile and Twenty Mile Creeks, respectively. The deepest embayment was terminated in the vicinity of the Short Hills range south of Twelve Mile Creek.

Recession of the Wisconsin glacial activity created several surface features on the upland plains. In the north-western segment of the Authority and adjacent to the escarpment, till-moraines are evident as far east as Clinton Township. Co-incident with the till-

* Fremlin, G. *Geomorphology of the Niagara Escarpment, Niagara River to Georgian Bay*; M.A. thesis University of Western Ontario, 1958, p.97.

moraine is an outwash which terminates in south Clinton Township and a prominent kame terrace developed just west of Fonthill. Beach terraces can be found south of the large kame at Fonthill.

Immediately south of these benches, and covering for the most part the entire region of the Authority are the Haldimand Clay Plains. The stratified clay and till material of these plains are also derivatives of the Lake Warren era. Isolated remnant beach terraces are evident in the south-western portion of the Authority, and in addition, two extensive bogs can be found in Wainfleet and Humberstone Townships. Prominent sand plains are apparent along the Lake Erie shoreline, especially along the most south-westerly border of the Authority.

3. Soil Geology

Surface deposits from the glacial activity have provided varied textured parent materials in creating the different soils within the Authority. Lake-laid sediments give rise to lacustrine soils, which are fine-textured; the coarser-textured soils are mixtures of lacustrine deposits and glacial fragments. The lacustrine deposits created the soils of the Haldimand Clay Plain, while the soils of the areas less influenced by lake water deposition can be found at the higher elevations. These coarse-textured soils can be found mainly in the north-west part of the Authority area.

Below the escarpment, the clay till is a composition of lacustrine deposition from Lake Iroquois and fragmented sedimentary rocks of the Niagara Escarpment.

It is clear from this, then, that the glacial processes that occurred in this region of Ontario have influenced the composition of both the soil types and physiography found within the Authority area.

4. Minerals

Non-ferrous mineral extraction has long played an important role in the economy of the area within the boundaries of the Authority. The extensive outcroppings of dolomitic limestone found along the Niagara Escarpment have provided crushed and cut stone for road construction and building materials for many years. One quarry near Thorold has been in continuous operation since 1887.

Bricks and tile are made from clay quarried in at least two areas, and sand for highway and building construction is being extracted from the Fonthill kame moraine area as well as the buried St. Davids Gorge.

A total of 55 pits and quarries were located in the Niagara Peninsula Conservation Authority during the 1970 summer survey. Of these, 40 were derelict or inactive and, of the remaining 15, sand was being extracted from 2, limestone and sand from 1, sand and clay from 1, clay from 1, gravel from 1, and crushed and/or cut limestone from 9.

While the mineral extraction industry plays an important economic role in the area, pits and quarries that have not been properly regulated create ugly scars upon the landscape. Under The Niagara Escarpment Protection Act and Regulations, effective screening of operations, site maintenance, dust control, and rehabilitation should help decrease the detrimental effect of these operations upon the landscape.

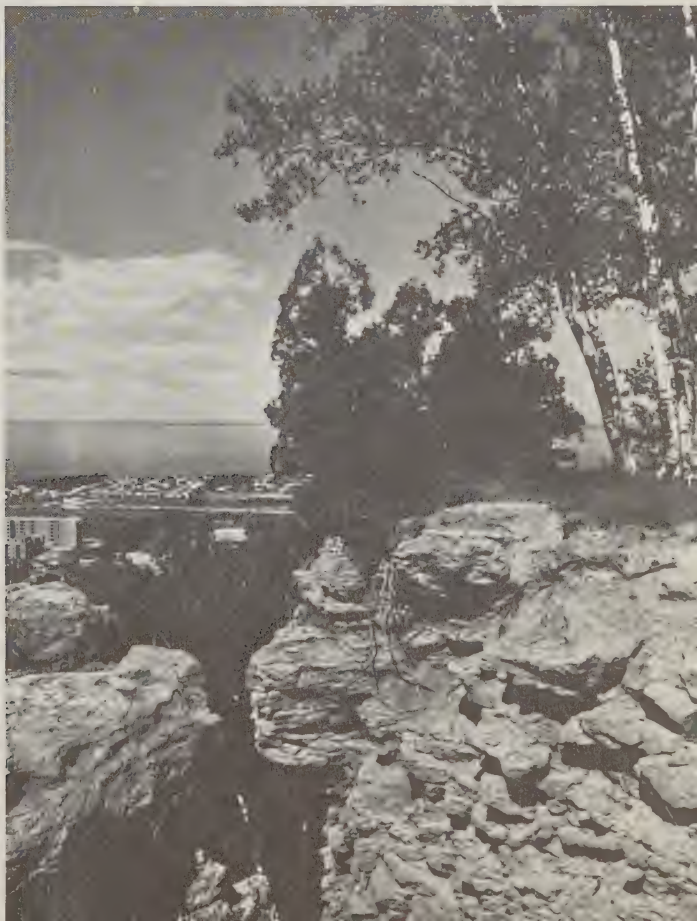
If properly rehabilitated, some of the abandoned or derelict pits and quarries would make suitable sites for recreation.

5. Natural Features

The Niagara Escarpment, extending from the Niagara River to Tobermory, is probably the most significant natural feature of Southern Ontario. Within the Niagara Peninsula Conservation Authority it forms an almost unbroken cliff from Niagara Falls to Hamilton, with scarp faces reaching a height of 300 feet. Niagara Falls need no elaboration here, except to note



Below the escarpment, remnant beach terraces formed from wave-washing action of Lake Iroquois, the forerunner of Lake Ontario.



Weather-resistant dolomitic rock is commonly found on top of the Niagara Escarpment.

that they occur where the Niagara River flows over the escarpment.

Another less obvious escarpment, the Onondaga, crosses the Niagara Peninsula from Fort Erie to Hagersville. This escarpment is for the most part buried under clay but exposures may be seen on Highway 58, south of Welland.

Another natural feature, readily recognized, is the rugged area south-west of St. Catharines known as the Short Hills. The area is a large re-entrant of the Niagara Escarpment filled with glacial drift. The drift material here is the end of a moraine deposit known as the Fonthill kame. The eroding waters of Twelve Mile Creek have carved this into one of the most thoroughly dissected areas of Southern Ontario.

Although not readily visible, except through a number of gravel pit exposures, the buried St. Davids Gorge was a course of the Niagara River before the glaciation. The gorge was filled during the glacial period, and the Niagara River diverted. A still buried part of the gorge extends from St. Davids to the Niagara "whirlpool".

Section 4

LAND RESOURCES

1. Supply and Geographic Distribution of Soils

The parent materials for the soil types found within the Niagara Peninsula Conservation Authority were greatly influenced during the last glacial periods.

Unsorted till materials are a consequence of the ice movements, while the lacustrine deposits are a result of a body of water that inundated the southern portion of the Authority during the last stages of the Wisconsin Ice Stage. The deltaic sand formations found on the bench terraces below the Niagara Escarpment are a result of stream deposits and wave-washing action of the early Lake Iroquois. Hence the soils within the Authority are derivatives from glacial till, glacio-lacustrine or lacustrine deposits. The following Great Soils Groups are represented: Grey-Brown Podzolic Group, Humic Greysol Groups, Dark-Grey Gleisolic Group, or the Brown Forest Group.

With reference to geographic distribution of various soil types, sandy loam soils are primarily located along the bench plains adjacent to the Lake Ontario shoreline, and clay loams can be found along the base of the Niagara Escarpment. Clay and clay loams are also located across the southern segment of the Authority area and a significant pocket of sandy loam soils is located in the vicinity of Pelham Township. Silt loam type soils are found mainly in the western segment of the Authority.

Soils most prevalent within the Authority area are listed as follows:

a. Berrien Series:

Soils of the Berrien Series belong to the Grey-Brown Podzolic Group and have developed on moderately deep outwash sands overlying clay. Drainage is considered to be imperfect. Some of these soils support fruit and vegetable crops.

b. Binbrook Series:

Soils of this series also belong to the Grey-Brown Podzolic Group and consist primarily of lacustrine silt loams overlying gray clay till. The clay till is imperfectly drained, and slight hard-panning may occur between the A and B horizons. Soils of this series mainly support forage and spring crops in Glanford and Binbrook Townships. Tiling has been successful for the production of specialty cash crops.

c. Caistor Series:

Soils of this series are of the Grey-Brown Podzolic Group with fine-textured clay loams overlying till or lacustrine materials. The topography is smooth to undulating with some pot-holes and the drainage is considered to be imperfect. For the most part, general farming is carried out on the Caistor soils.

d. Farmington Series:

The shallow soils of this series overlie limestone bedrock, and are of the Brown Forest Group. The soils are usually less than 12 inches in depth and have limited agricultural potential. Topography is rather flat and the Farmington soils are generally found on the brow of the Niagara Escarpment. Since these soils are well drained, droughtiness may occur in late summer.

e. Haldimand Series:

The very fine textured soils of this series belong to the Grey-Brown Podzolic Group and are formed on till or lacustrine sediments. The Haldimand clay soils are imperfectly drained, hence agricultural productivity is hampered by drainage problems. The topography is rolling to smooth uplands on which hay, grain and dairy farming are carried out.

f. *Jeddo Series:*

The clay textured soils of this series have developed on calcareous till, primarily along the Iroquois benches to the Humic Gleysol Group. The topography is nearly flat and supports fruit production, with grape vineyards utilizing the greatest acreage.

g. *Lincoln Series:*

Soils of this series belong to the Dark-Grey Gleisolic Group and are derivatives of grey clay till parent material. The topography is generally flat to depressional, and often tiling is necessary as the drainage is poor. Some of the Lincoln soils are utilized for grape production.

h. *Trafalgar Series:*

Parent material of this series is reddish silty clay, with the red colour derived from the Queenston shales. The soils may vary in texture due to differential weathering of the shales and are primarily found on the Iroquois bench. They are imperfectly drained and belong to the Grey-Brown Podzolic Group.

i. *Vineland Series:*

Calcareous medium and fine outwash sands are the parent materials of the soils in this series, which are of the Grey-Brown Podzolic Group. The sandy soils are imperfectly drained due to underlying clay, but where depths of 2 to 8 feet are found, they provide good agricultural potential. The soils in this series are best suited for peach production.

j. *Welland Series:*

The soils of this series belong to the Humic Gleysol Group and are primarily clay loam overlying compacted clay. The drainage is poor on the smooth to undulating topography on which general farming is generally carried out.

Percentage of Soil Types found within the Niagara Peninsula

<i>Soil Type</i>	<i>Percentage</i>
Sand	1
Sandy loam	15
Loam	9
Silt loam	19
Clay loam	28
Clay	25
Peat	3

2. Land-Use Capability of Soils

a. *Agriculture*

The different soil types within the Authority area obviously display various degrees of suitability for agricultural production. Soils found along the Iroquois Plain are most suitable for fruit production; although different soil types are usually considered better for tree fruits than for small fruits and grape production. Grapes are generally grown on clay or clay loam soils. A few vineyards have been established on sandy soils.

Sandy soils are required for peach trees and the depth of the moisture table within the soil is often critical. Peach and cherry trees are the most demanding of the soil and its associated nutrients.

The soil capability system recognizes seven classes with the first four classes (Classes 1, 2, 3 and 4) indicating the suitability of better lands for field crop cultivation. The suitability decreases as the number increases. Class 1 soils are considered to have no significant limitations for agricultural production and the Class 4 group delineates the lands which are

marginal for crop production. Class 1 to 4 lands are also suitable for permanent pasture as well as for cultivated field crops.

In some locations where the soil and related topographical features display a variety of combinations, complex classes of agricultural land capability are found.

Class 1: Soils in this class have no significant limitations that restrict their use for field crops. They are deep, moderately drained soils on relatively flat slopes. Moisture retention of the soil must be good and the regular application of fertilizer is necessary to maintain the fertility of the soil.

Class 2: Soils in this class have moderate limitations that reduce the choice of crops or require moderate conservation practices. The soils in this class are generally deep, with a gentle rolling topography. However, some limitations may be imposed due to lower fertility potentials or excessive water retention. This high water content can restrict working periods on the soils or alter the structure of the soil. The crop yields are medium but, by means of good cultivation measures and drainage programs, the limitations of the soils can be overcome.

Class 3: Soils of this class have severe limitations that reduce the choice of crops or require special conservation practices. Soils of this group generally display gentle rolling undulating forms of topography with a number of limitations which affect the rating of soil. Care must be exercised to improve the fertility and the structure of the soil. Stoniness and the shallow soil cover over the bedrock also have a limiting effect on root growth.

Class 4: Soils in this class have severe limitations that restrict the choice of crops and require special conservation practices or very careful management. The class of land can be considered as the terminal point in considering lands for economic agricultural production. Some soils, if given intensive attention, may provide a reasonable crop yield. However, much of this land may be better for forestry purposes. Soils in this group are generally coarse-textured and consequently the permeability of the soil is high. In addition to the lower water-holding capacity, low fertility, stoniness and the shallow depth to bedrock greatly hinder field crop production.

Classes 5, 6 and 7: Soils of these three groups are not suitable for cultivation, due mainly to degrees of stoniness or shallow depths of soil to bedrock.

Some Class 5 and 6 lands could be used for grazing purposes, while Class 7 land is not suited for agricultural production and, in fact, should be diverted to other uses such as forestry, wildlife or recreation.

Class 0: Organic soils are not placed in capability classes.

Percentage of Agricultural Land Capability Found Within the Niagara Peninsula					
	Classes (1, 2 & 3)	Class 4	Class 6	2-6 Complex	5-7 Complex
Percentage	58	10	9	13	10

b. Forestry

Forest cabability classifications are based upon the inherent ability of a site; soil conditions, surface features, and climatic characteristics are related to the ability of various tree species to produce commercial trees. The best land for timber production is rated as Class I land,

while Class VIII land has the least potential for commercial tree production. Within the classification range, Class IV land is considered to be the cut-off point that will support suitable stands of commercial timber, i.e., productivity level is usually from 51 to 70 cubic feet per acre per annum.

A brief description of the forest capability classes for commercial tree production follows:

Class I: Lands having no important limitations to the growth of commercial forests. The medium-textured soils on these lands are fertile and generally well drained. Productivity is usually greater than 111 cubic feet per acre per annum.

Class II: Lands having slight limitations to the growth of commercial forests. Soil conditions, on these lands, are considered to be generally favourable as the adverse factors tend to be rather limited in degree to climatic attributes, root depth restrictions or fertility differences. Productivity considered from 91 to 110 cubic feet per acre per annum.

Class III: Lands having moderate limitations to the growth of commercial forests. These lands possess medium to fine-textured soils with moderate water-holding capacities and may also display periodic moisture imbalances. Production usually ranges from 70 to 90 cubic feet per acre per annum.

Class IV: Lands having moderately severe limitations to the growth of commercial forests. The soil characteristics may vary greatly in terms of moisture, structure, fertility, rooting depths and the presence of carbonates to restrict productivity of the land to 51 to 70 cubic feet per acre per annum.

Class V: Lands having severe limitations to the growth of commercial forests. Lands in this classification have soils that tend to be shallow with poor water-holding capacities and low fertility characteristics. Excessive stoniness and high carbonate levels restrict the productivity of the land to 31 to 50 cubic feet per acre per annum.

Class VI: Lands having very severe limitations to the growth of commercial forests. Lands in this classification are, for the most part, composed of poorly drained organic soils. High levels of soluble salts and inundation occur often to hamper the productivity of the land.

Class VII: Lands having severe limitations which preclude the growth of commercial forests. In this class, the land may be subject to frequent flooding or, in extremely dry soils, active erosion may be present. Frequent inundation and high toxic levels of soluble salts in the soils contain the productivity of the land to less than 10 cubic feet per acre per annum.

The Niagara Authority has 75 per cent of its total area rated as Class I to III land, 24 per cent is rated as Class IV land and the remaining 1 per cent is rated Class VI.

The wet lands found in the Humberstone and Wainfleet marsh areas do not provide high productive levels for commercial tree species, and for this reason the lands have been assigned Class IV and Class VI forest capability ratings. In other areas of the Authority, Class III or better ratings have been assigned; however, the limiting factors are considered to be soil moisture content and root depth restrictions. Forest capability ratings in the Authority area reflect three main limiting characteristics: 1) physical restriction to rooting caused by dense or consolidated layers other than bedrock, 2) soil moisture deficiency and 3) excessive soil moisture.

3. Natural Vegetation

Climate and soils both influence the forest stands within the Authority area and the forest cover is part of the Niagara Section of the Deciduous Forest Region as described by Rowe*.

* Rowe, J.S., *Forest Regions of Canada*: Canada Dept. of Northern Affairs and National Resources, Forestry Branch – Bulletin 123.

The trees are predominately broadleaved and for the most part are typical of the deciduous forest found south of the Great Lakes.

In cover-typing the various woodlots in the Authority, the following groups of tree species were found: beech-sugar maple, ash-hickory, and white oak-black oak-red oak. Silver maple, white elm, white pine, black walnut, sycamore and the American sweet chestnut and tulip trees were also found during the survey.

4. Management of Scrublands

Areas covered with woody shrubs and low growing non-commercial tree species are considered to be scrublands. These sites can be divided into two types: dry and wet scrublands. Dry scrublands commonly contain species such as wild apple, hawthorn, sumac and prickly ash. Wet scrublands commonly contain low-growing willow species and dogwoods. Dry scrubland is often pasture land that has been allowed to revert to woody shrubs due to improper pasture management. Often pastures or fields subjected to urban expansion pressures and land speculation are abandoned and develop into scrublands. Wet scrublands usually denote excessive soil moisture conditions.

In some instances, appropriate tile drainage systems could improve the wet land for agricultural purposes, rather than leaving it idle.

The Townships of Binbrook, Humberstone, Moulton, Wainfleet and Willoughby possess areas of both wet and dry scrublands within their boundaries – while Caistor, Canborough, and North Cayuga Townships have numerous sites of dry scrublands.

With respect to either type of scrubland, the parcel should be considered on its individual potential and should the land be more suitable for agricultural production, then field renovation work should be carried out. If reforestation is more appropriate for the site, then suitable trees should be planted where feasible. In some locations, the establishment of vegetative cover should be left to take its natural course.

Section 5 WATER RESOURCES

1. Characteristics of Drainage Systems

The topographic features of the Niagara Peninsula define the drainage systems. For descriptive purposes the area of the Authority can be divided into three principal basins: the Lake Erie, Niagara River and Lake Ontario drainage systems. In addition, artificial canals play a significant role. Municipal drainage ditches are also important.

a. *The Lake Erie Drainage System*

There are no streams of any size or consequence draining into Lake Erie. Of the small streams that do, most of the original channels were straightened and dredged to drain the flat clay plain of Haldimand and Welland Counties.

b. *The Niagara River Drainage System*

A number of streams drain into the Niagara River: The Welland River and Black Creek are the most important ones; with Baker, Bayers, Frenchman, Miller and Usshers Creeks serving mainly as municipal drainage ditches with less than a 10-square-mile drainage area each.

i. *Welland River*

This river, having a drainage area of 348 square miles, originates at a small pond near Southcote, just inside the Township of Ancaster. Its course is a meandering 82 miles, and its gradient rather shallow. It joins the Niagara River at Chippawa, but the construction of Hydro's Chippawa-Queenston Power Canal diverted the flow so that both rivers now empty into the canal.

Because of the Welland River's shallow gradient — the total fall is about 50 feet over a distance of 56 miles — its water level is affected by the operation of control devices of the power plants.

ii. *Black Creek*

Total drainage area of this creek is 40 square miles and the main stream is about 11 miles in length. The headwaters are located in the marshy area of the former Humberstone Township, now part of the City of Port Colborne. Black Creek enters the west branch of the Niagara River, about six miles upstream from the Welland River's confluence with the Niagara River. The gradient is remarkably flat, the total fall between Stevensville and its confluence being only 0.4 feet in 4.6 miles or less than 0.1 feet per mile. The control weir on the Niagara River above the falls has backwater effects up to near Stevensville.

c. *The Lake Ontario Drainage System*

There are numerous streams emptying into Lake Ontario, and most of them are named according to their approximate distance from the mouth of the Niagara River. The two most important streams are Twelve and Twenty Mile Creeks.

i. *Twelve Mile Creek*

This creek has a drainage area of 51 square miles and its main course is 14 miles long. It rises in the Township of Pelham at an elevation of 630 feet, descends rapidly over the escarpment and enters Lake Ontario at Port Dalhousie. Below the escarpment the flow is mainly the tailwater of the De Cew generating station, with an average discharge of about 7,000 cubic feet per second (c.f.s.) Discharges from industrial plants through the Old Welland Canal are also significant.

ii. *Twenty Mile Creek*

This creek has a drainage area of 122 square miles and 97 per cent of this is above the

escarpment. The creek rises just inside the southern limits of the City of Hamilton, and for the most part of its 49-mile length, it follows a meandering west-easterly course across the clay plain. The slope is gentle and the flow is sluggish. At Ball's Falls, about one mile south of Highway 8, it drops 85 feet over the escarpment through a gorge and enters Lake Ontario at Jordan Harbour.

d. *The Canal System*

There are four artificial canals: the Welland Ship Canal, the Old Welland Canal, the Chippawa Power Canal and the Welland Feeder Canal.

i. *The Welland Ship Canal*

This canal bisects the Regional Municipality of Niagara in a south-north direction, joining Lake Erie and Lake Ontario, as part of the St. Lawrence Seaway. Ten Mile Creek, Beaver Dams Creek and Shriners Creek have been diverted from Twelve Mile Creek, and now flow into the Welland Ship Canal. A stub end of Beaver Dams Creek is siphoned under the canal and pumped into Gibson Lake, and a short section of Shriners Creek is siphoned under the canal into the Old Welland Canal.

The Welland Ship Canal provides little drainage. Most streams are carried under the canal grade in artificial conduits, so that their drainage is not affected. Largest of these is the Welland River, whose water is carried under the canal in the City of Welland by an inverted siphon with six tubes, each 22 feet in diameter.

At Allanburg, water is diverted to the De Cew generating station, and this water eventually enters Twelve Mile Creek, downstream of the tailrace. Part of this diverted water is used for the municipal supply of St. Catharines.

ii. *The Chippawa-Queenston Power Canal*

This canal and two tunnels supply the Sir Adam Beck station with water from the Niagara River and the Welland River. The tunnels follow a northerly direction from the intake point near Chippawa, pass under the City of Niagara Falls and discharge into the downstream power canal which leads to the forebays of the generating plants. The canal joins and crosses the Chippawa-Queenston Power Canal immediately upstream from the generating station. A second connection exists between the two canals, by a channel connecting the forebays.

iii. *The Old Welland Canal and the Feeder Canal*

Before Confederation the only transportation routes available to the early traders were rivers and lakes, which, although plentiful, offered some formidable obstacles to overcome. Freeze-up in the winter, treacherous rapids, long portages and waterfalls like the Niagara, made travellers dream of a reliable water route from the lower Great Lakes to the upper Great Lakes.

The first determined steps to overcome the difficulties caused by the 326-foot difference in elevation between Lake Ontario and Lake Erie, were initiated by W. Hamilton Merritt, who became convinced of the feasibility of a man-made navigable waterway. In 1824 an Act granted charter to the Welland Canal Company and on November 30, 1824, construction began at Allanburg.

The route followed Twelve Mile Creek from Lake Ontario, then by canal and locks, it joined the Welland River, then called Chippawa Creek, and entered the Niagara River safely above Niagara Falls.

Problems with adequate water levels forced the Welland Canal Company to augment the flow in the canal near the summit at Port Robinson. This led to the concept of the feeder canal which would supply water from the Grand River at Dunnville, and would, in addition, provide an alternate and safer route to reach Lake Erie. The strong currents of the Niagara River at times proved to be hazardous. The feeder canal came

into being in the fall of 1829. As marine traffic increased, a continuous improvement program was implemented and a gradual deepening of the feeder canal became a necessity. As an alternate choice of entry into Lake Erie was needed, a new canal was constructed from Port Maitland to Stromness, and a lock with 9-foot draft was built at Port Maitland.

Between 1845 and 1850 this was the only route available to Lake Erie, due to the construction of a new canal between the summit and Port Colborne. With the increased traffic, the Grand River could not supply all the water needed and modifications were made to feed the system directly from Lake Erie. These modifications were completed in 1881.

With the advent of steam as driving power for ships and the ever increasing size of marine vessels, the draft afforded by the feeder canal was not sufficient and a new route, the Welland Ship Canal, was constructed. The Welland Ship Canal used Lake Erie water entirely (about 77 acre-feet per lockage) so that the feeder canal was no longer required. The privy council decided to return portions of the feeder canal to the municipalities together with a grant to maintain the canal and its structures.

Over the years, lack of a definite purpose has led to a general demise of the canal, to a point where it is degraded to a large open ditch whose waters are shallow, weedy and at times most unattractive. Parts of the branch from Dunnville to Stromness are now backfilled with earth. The feeder canal has no drainage area, since most streams pass under its grade level, via pipes and siphons.

The Old Welland Canal is now used to carry industrial waste through the Town of Thorold and the City of St. Catharines into Twelve Mile Creek. Parts of the Old Welland Canal are backfilled and the lands are under development.

e. Municipal Drainage Ditches

Because of the flatness of the terrain and some of the soil capability classes encountered, several townships have been involved in open ditch drainage construction programs. Between 1928 and 1969, about a hundred drainage projects were undertaken by the townships within the Authority area at a total estimated capital cost of \$1,087,000. Most active appears to have been the Township of Wainfleet, where, between 1950 and 1969, 22 drainage courses were dug at a cost of over \$450,000.*

The municipal drains observed during the 1970 survey showed a range in condition from very good to apparently abandoned. Ditches which were filled with silt and overgrown with weeds suggested to the survey party that the projects had been abandoned and were no longer functional.

2. Water Yield

There are two water gauging stations within the Conservation Authority area. From the records available the maximum yearly runoff was calculated at 17.2 inches within the Twenty Mile Creek watershed, and the minimum was 6.06 inches. For the corresponding period of time, the values observed within the Welland River watershed were: maximum runoff 13.62 inches, minimum 5.26 inches and the mean 9.46 inches. The maximum daily discharge on Twenty Mile Creek was observed at 4,580 c.f.s. which corresponds to 1.52 inches of runoff, while the measured maximum daily flow on the Welland River was 2,790 c.f.s., which equals 1.20 inches of runoff for 24 hours. Both Twenty Mile Creek and the Welland River had periods of zero flow throughout the years of record.

The highest flows occur during the month of March and the lowest or zero flow is most evident in August.

* From Department of Municipal Affairs data.

Table 5-1: Water Yield

River	Discharge, Annual Average			Runoff Inches Yearly		
	Max. c.f.s.	Min. c.f.s.	Mean c.f.s.	Max.	Min.	Mean
Niagara River at Queenston DA: 255,000 sq. mi.	227,000	157,300	192,800	12.18	8.44	10.35
Welland River at Merritt's Church DA: 87 sq. mi.	86.6	33.4	60.1	13.62	5.26	9.46
Twenty Mile Creek at Ball's Falls DA: 113 sq. mi.	142.0	50.0	79.5	17.20	6.06	9.62

3. Ground Water

The water present below the ground surface is referred to as ground water. The zone of saturation is the area of the soil where water fills all the voids between the soil particles, and the upper limit of this zone is commonly known as the water table. Coarse-grained soil, which permits the free movement of water is referred to as an aquifer. Gravels and sands are good aquifers, whereas clays are not. Clays are capable of retaining large quantities of water but movement of water through the very fine particles is extremely slow.

For a well to be productive, it is essential that it intercept a good aquifer.

The Counties of Haldimand, Welland and most of Lincoln are located on the clay plain and since this impervious layer covers the aquifers, ground water conditions are not favourable.

The total number of wells dug in Lincoln and Welland Counties during the period of 1960-63 is 754.* Of this total, Lincoln County had 342 wells and Welland County reported 412. The average percentage of fresh-water producing wells in Welland County was 78 per cent and the remaining 22 per cent of the wells produce saline and/or sulphurous water. In the County of Lincoln the ratio was 89 per cent fresh water and 11 per cent sulphurous and/or saline.

During the construction of the various Welland canals many of the shallow wells went dry and the practice of buying fresh water is widespread throughout the Authority.

4. Water Quality

The Niagara Peninsula has gone through a dramatic change in the past few decades from a predominantly agricultural to a highly industrialized region. The development of industry together with the increase in population has been accompanied by deterioration of water quality.

Municipal sewage disposal and industrial wastes, together with significant changes in agricultural practices are all important factors in the decline in water quality. These problems are dealt with in more detail elsewhere in the report. Suffice it to say here that water quality is a most important consideration in the water resources picture.

5. Water Use and Management

Efforts to provide some measure of water management date back to the early 1800s. The mill operators, the factories relying on water power and the various canal systems all tried to secure a constant supply of water. In spite of this, dam construction was not undertaken as part of the solution, and the only such structure built was a low weir at Ball's Falls. Efforts were made to provide irrigation water for fruit farmers on an individual basis, and between

* Ontario Water Resources Commission, *Ground Water in Ontario*, 1968.

the foot of the escarpment and Lake Ontario, a number of small private reservoirs are to be found. The Conservation Authority has established a reservoir at Virgil, on Four Mile Creek.

The principal water managing agency is the St. Lawrence Seaway Authority, which supplies about 800 c.f.s. of Lake Erie water through the Welland Ship Canal. Of this, up to 7,800 c.f.s. flow through the De Cew generating station near St. Catharines, and the balance of flow is used for lockage, municipal and industrial water supply and for the dilution of wastes.

The Niagara River and its management for power generation is discussed elsewhere in this report.



Penstocks of Ontario Hydro's De Cew Falls power generating station use water from the Welland Ship Canal to power the turbines. Twelve Mile Creek is in the foreground.

Section 6

FISH AND WILDLIFE RESOURCES

1. Fish

The fish which occur in the waters of the Niagara Peninsula include many species, but there is no commercial fishing in the region.

In Twenty Mile Creek alone, 20 species of fish were collected in 1961 during a survey by the Conservation Authorities Branch. In 1964, the Branch made another survey of the fish and invertebrates in the Welland River. This survey was prompted by reports that there had been a "complete" fish kill in the river in the winter of 1961-62. In this survey, with the use of a bag seine, 14 species of fish were identified in the Welland River above Welland. Amongst these were the white crappie, black crappie, yellow perch and northern pike. These fish could hardly have ascended the river because the pollution is so severe below Welland. These species must, therefore, have survived the fish kill.

"Bass" have been introduced into the quarry ponds west of Port Colborne. It is reported that both largemouth and smallmouth bass were introduced. As one of the specimens caught by an angler was reported as weighing eight pounds, it is highly probable that this specimen was a largemouth bass. Bass were seen on the 1970 survey in these ponds, but as none were caught, the exact species now in the pond is not certain. There appeared to be little territory suitable for spawning of smallmouth bass in these ponds.

Brook trout and brown trout have been introduced many times into the upper reaches of Twelve Mile Creek, but as the larger properties have been subdivided into smaller properties and several streams are posted against trespass, the number of fish introduced has declined in the last 10 years. A dead brown trout was found in Twenty Mile Creek below Ball's Falls so the species must have been introduced into the creek also. Many residents at Jordan have reported that they caught bowfin above Jordan, and there is no reason to doubt this.

Rainbow trout have been introduced in Twelve Mile Creek below De Cew Falls, and still exist there in small numbers in spite of the debris. Planted trout are reported in the forebay of the St. Catharines filtration plant.

The fish of the Welland River above the City of Welland, at a convenient station west of Chambers Corners, were checked in 1970 with two gill nets set in Lot 20, Concession VII, of the Township of Wainfleet on June 18 and 19, 1970. Excellent co-operation was received from the Department of Lands and Forests who supplied the nets and supervised the setting of them.

The following eight species of fish were taken in the two nets, with the total numbers taken shown in brackets after the name of each fish:

Black crappie	(82)
White crappie	(81)
Yellow bullhead	(21)
Northern pike	(6)
Channel catfish	(6)
Brown bullhead	(5)
Sheepshead	(2)
Pumpkinseed	(2)

Mean lengths of two of the fish (measured from the tip of snout to the end of the lateral line close to the caudal fin) were as follows: White crappie 7.2 inches, black crappie 7.1 inches. The two largest channel catfish measured 17 and 11½ inches. The two largest northern pike measured 14 and 11 inches.

There are two ponds in the Chippawa Creek Conservation Area. The larger one is part of a former oxbow of the Welland River, now cut off from it by a dam. A trap net caught little in this pond. However, a 100-foot bag seine also used in the pond caught two small-mouth bass. Several hundred crappies, pumpkinseeds, and bluegills were also caught in this haul. Filamentous algae were abundant in this pond in August, 1970. Two anglers were also seen catching bass of 10- and 12-inch lengths in the pond.

One pond in the region has been stocked experimentally with muskellunge. Although none were caught in nets placed in this pond, a few "pike" have been reported by anglers. These may have been muskellunge of less than the legal size limit.

A complete list of those species of fish caught or reported in the Niagara Authority is included in the appendix.

2. Birds

a. Inventory

The casual or serious study of birds has now become a major pursuit of a considerable segment of the population. There has been a phenomenal growth in this interest in birds, greatly increased by the publication of several efficient and very accurate field guides. With a few exceptions (particularly the Starling and Red-winged Blackbird), birds are harmless to man's life, and many species have beneficial habits, such as the eating of harmful insects and weed seeds. Other birds such as gulls and the Turkey Vulture also fulfil a useful and important role as scavengers. As the population grows the percentage of people interested in birds is also increasing.

The list in this section was prepared almost entirely from the records of Mr. Harold Lancaster of Welland, a very competent naturalist, who added additional species from the authentic records published in *Birds of the Niagara Frontier* by Harold Mitchell. The arrangement and names in the list follow those used in the *American Ornithologists Union Check-list* (5th Edition, 1957).

Three hundred and four species of birds have been positively identified in the Niagara region or about its shores (discounting the Passenger Pigeon and Wild Turkey, now extinct in the area). Of these 304, thirty are permanent and breeding residents and may be seen at any time of the year. Seventy-seven species are seen in migration only. A large number of other species are migrants which may also breed in the region and overwinter, or are also summer or winter visitors. A few species are seen only as summer or winter visitors.

Birds of the Niagara Region

In the following list the names of birds which are known to breed in the region are followed by an asterisk(*). The symbols following the name of any bird are as follows:

PR. Permanent Residents, breeding in summer.

* Breeds in the region in summer, may also migrate through the region.

M. Migrant

O. Occasional

OM. Occasional Migrant

SR. Summer Resident, no breeding evidence.

Ra. Rare

SV. Summer Visitor

WR. Winter Resident

CWR. Common Winter Resident

WV. Winter Visitor

A. Accidental (birds which are out of their normal range in the region, and for which there are few records).



This abandoned stone quarry near Port Colborne harbours a population of bass.

BIOLOGICAL CONDITIONS OF THE HEADWATERS OF TWELVE MILE CREEK

SUMMER CONDITIONS



LEGEND

PERMANENT FLOW COLD ———
PERMANENT FLOW WARM ———
INTERMITTENT WARM ———
DRY (DRIES UP COMPLETELY
IN SUMMER) ———
SAMPLING STATIONS ———

SCALE — FEET
0 1000 2000 3000 4000

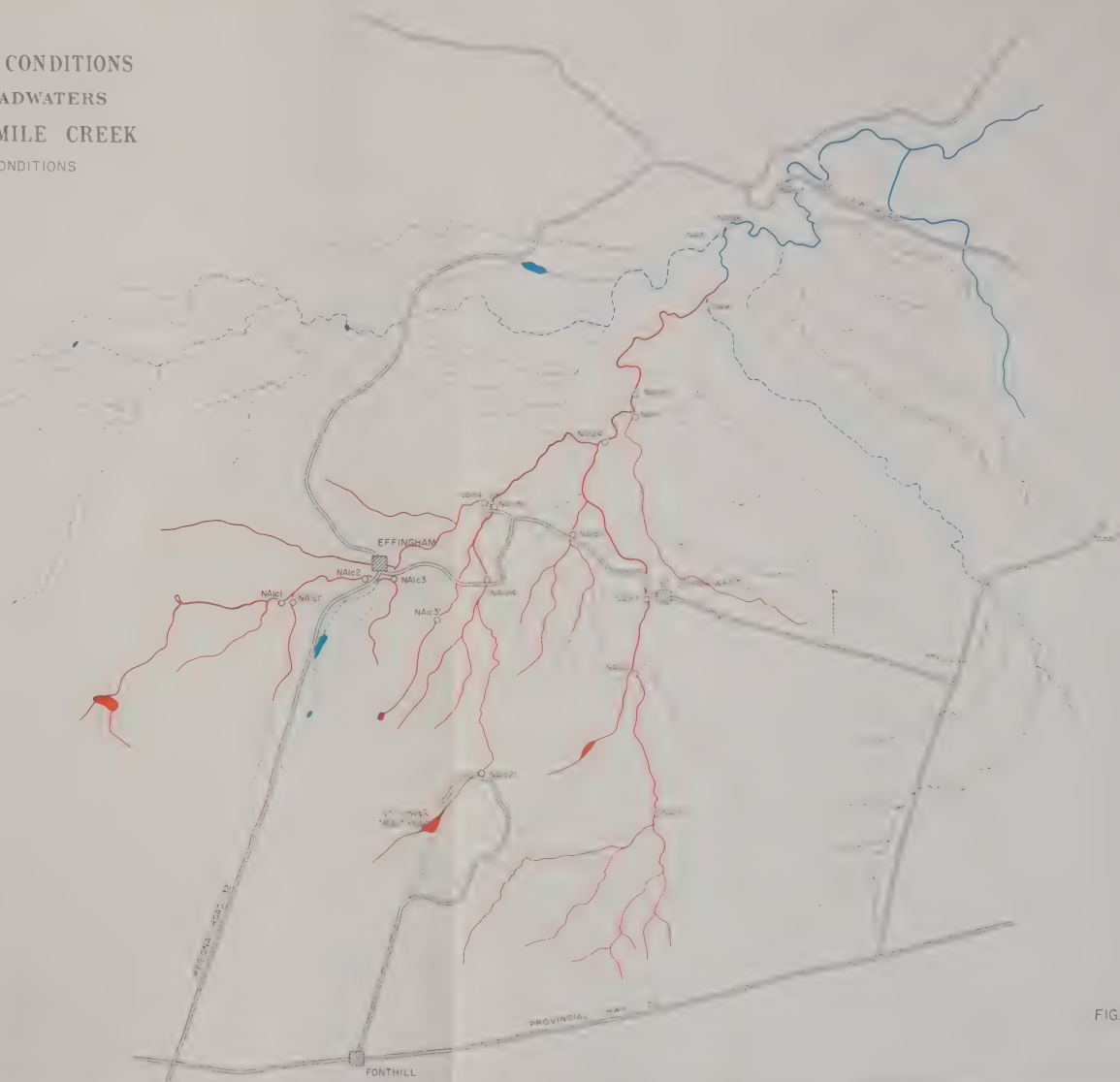


FIG. 6-1

Species	Status	Species	Status
Common Loon	M.	Common Scoter	M.
Red-throated Loon	OM.	Ruddy Duck*	M.
Red-necked Grebe	OM.	Hooded Merganser	M.WV.
Horned Grebe	M.WV.	Common Merganser	M.WR.SV.
Western Grebe	A.	Red-Breaster Merganser	M.WR.SV.
Pied-billed Grebe*		Smew	A.
Wilson's Petrel	A.	Turkey Vulture	SR.
White Pelican	A.	Black Vulture	A.
Gannet	A.	Goshawk	OM.WV.
Double-crested Cormorant	OM.WV.	Shape-shinned Hawk	M.WV.
Great Blue Heron*		Cooper's Hawk	M.WV.
Green Heron*		Red-tailed Hawk*	PR.
Little Blue Heron	A.	Red-shouldered Hawk	SR.
Cattle Egret	Ra.SV.	Broad-winged Hawk	M.
Common Egret	SV.	Rough-legged Hawk	WR.
Snowy Egret	A.	Golden Eagle	Ra.OM.
Black-crowned Night Heron*		Bald Eagle	Ra.M.
Least Bittern*		Marsh Hawk*	SR.WV.
American Bittern*		Osprey	M.
Glossy Ibis	A.	Peregrine Falcon	Ra.M.
Mute Swan	Ra.	Pigeon Hawk	OM.
Whistling Swan	M.	Sparrow Hawk*	PR.
Canada Goose	M.O.W.	Ruffed Grouse*	PR.
Brant	OM.	Bobwhite	Ra.PR.
Snow Goose	OM.	Ring-necked Pheasant*	PR.
Blue Goose	OM.	Gray Partridge	PR.
Mallard	PR.	King Rail	O.SR.
Black Duck	PR.	Virginia Rail*	
Gadwall	OM.WV.	Sora*	
Pintail	M.WV.	Purple Gallinule	A.
Green-winged Teal	M.	Common Gallinule*	
Blue-winged Teal*		American Coot*	WV.
European Widgeon	A.	American Oyster-catcher	A.
American Widgeon*	M.O.SR.WV.	Semipalmated Plover	M.
Shoveler*	OM.	Piping Plover	M.
Wood Duck*		Killdeer*	WV.
Redhead	M.WR.	American Golden Plover	M.
Ring-necked Duck	M.WV.	Black-bellied Plover	M.
Canvasback	M.WV.	Ruddy Turnstone	M.
Greater Scaup	M.WR.	American Woodcock*	
Lesser Scaup	M.	Common Snipe	M.
Common Goldeneye	M.WR.SV.	Whimbrel	M.
Bufflehead	M.WV.	Upland Plover*	
Oldsquaw	WV.	Spotted Sandpiper*	
Harlequin Duck	O.WV.	Solitary Sandpiper	M.
Common Eider	Ra.	Willet	Ra.M.
King Eider	WV.	Greater Yellowlegs	M.
White-winged Scoter	M.WV.	Lesser Yellowlegs	M.
Surf Scoter	M.	Knot	M.

Species	Status	Species	Status
Purple Sandpiper	WV.	Long-eared Owl	O.WR.
Pectoral Sandpiper	M.	Short-eared Owl	O.PR.CWR.
White-rumped Sandpiper	M.	Boreal Owl	O.WV.
Baird's Sandpiper	M.	Saw-whet Owl	WV.
Least Sandpiper	M.	Whip-poor-will	M.
Curlew Sandpiper	A.	Common Nighthawk*	
Dunlin	M.	Chimney Swift*	
Short-billed Dowitcher	M.	Ruby-throated Hummingbird*	
Long-billed Dowitcher	Ra.M.	Belted Kingfisher*	O.WV.
Stilt Sandpiper	O.M.	Yellow-shafted Flicker*	PR.
Semipalmated Sandpiper	M.	Pileated Woodpecker	PR.
Western Sandpiper	Ra.M.	Red-bellied Woodpecker	O.
Buff-breasted Sandpiper	Ra.M.	Red-headed Woodpecker*	PR.
Marbled Godwit	Ra.M.	Yellow-bellied Sapsucker	M.
Hudsonian Godwit	O.M.	Hairy Woodpecker	PR.
Ruff	A.	Downy Woodpecker	PR.
Sanderling	M.	Northern Three-toed Woodpecker	A.
American Avocet	Ra.M.	Eastern Kingbird*	
Red Phalarope	O.M.	Western Kingbird	A.
Wilson's Phalarope	O.M.	Great Crested Flycatcher*	
Northern Phalarope	Ra.M.	Eastern Phoebe*	
Parasitic Jaeger	Ra.M.	Yellow-bellied Flycatcher	O.M.
Glaucous Gull	WV.	Acadian Flycatcher*	O.
Iceland Gull	WV.	Traill's Flycatcher*	
Great Black-backed Gull	WV.Ra. SR.	Least Flycatcher*	
Herring Gull	PR.	Eastern Wood Pewee*	
California Gull	A.	Olive-sided Flycatcher	O.M.
Ring-billed Gull*	PR.	Horned Lark*	PR.
Mew Gull	A.	Tree Swallow*	
Black-headed Gull	Ra.WV.	Bank Swallow*	
Laughing Gull	Ra.WV.	Rough-winged Swallow*	
Franklin's Gull	Ra.M.	Barn Swallow*	
Bonaparte's Gull	WR.	Cliff Swallow*	
Little Gull	Ra.WV.	Purple Martin*	
Ivory Gull	A.	Black-billed Magpie	A.
Black-legged Kittiwake	Ra.WV.	Blue Jay*	PR.
Forster's Tern	Ra.M.	Common Crow*	PR.
Common Tern*		Black-capped Chickadee*	PR.
Caspian Tern	O.M.	Boreal Chickadee	O.WV.
Black Tern*		Tufted Titmouse	O.WR.
Thick-billed Murre	A.	White-breasted Nuthatch*	PR.
Rock Dove*	PR.	Red-breasted Nuthatch	M.O.WV.
Mourning Dove*	PR.	Brown Creeper	M.O.WR.
Yellow-billed Cuckoo*		House Wren*	
Black-billed Cuckoo*		Winter Wren	M.WV.
Barn Owl*	O.PR.	Carolina Wren*	O.
Screech Owl*		Long-billed Marsh Wren*	
Great Horned Owl*		Short-billed Marsh Wren*	
Snowy Owl	WV.	Rock Wren	A.

Species	Status	Species	Status
Mockingbird*	PR.	Northern Waterthrush	M.
Catbird*		Louisiana Waterthrush	M.
Brown Thrasher*		Kentucky Warbler	O.M.
Sage Thrasher	A.	Connecticut Warbler	O.M.
Robin*	WV.	Mourning Warbler	M.Ra.SR.
Wood Thrush*		Yellowthroat*	Ra.WV.
Hermit Thrush	M.O.SV.	Yellow-breasted Chat*	O.
Swainson's Thrush	M.	Hooded Warbler	Ra.M.
Grey-cheeked Thrush	O.M.	Wilson's Warbler	M.
Veery*		Canada Warbler	M.
Eastern Bluebird*		American Redstart*	
Blue-gray Gnatcatcher*	O.SR.	House Sparrow*	PR.
Golden-crowned Kinglet	M.WV.	Bobolink*	
Ruby-crowned Kinglet	M.O.WV.	Eastern Meadowlark*	WV.
Water Pipit	M.	Western Meadowlark	O.SR.
Bohemian Waxwing	Ra.WV.	Yellow-headed Blackbird	A.
Cedar Waxwing*	PR.	Red-winged Blackbird*	WV.
Northern Shrike	WV.	Orchard Oriole*	O.
Loggerhead Shrike*	O.WV.	Baltimore Oriole*	
Starling*	PR.	Rusty Blackbird	M.O.WV.
White-eyed Vireo	O.M.	Common Grackle*	O.WV.
Yellow-throated Vireo*	O.SR.	Brown-headed Cowbird*	O.WV.
Solitary Vireo	M.	Western Tanager	A.
Red-eyed Vireo*		Scarlet Tanager*	
Philadelphia Vireo	O.M.	Cardinal*	PR.
Warbling Vireo*		Rose-breasted Grosbeak*	
Black-and-white Warbler	M.	Indigo Bunting*	
Prothonotary Warbler	O.SR.	Dickcissel	O.WV.
Golden-winged Warbler	SR.	Evening Grosbeak	WV.
Blue-winged Warbler	Ra.SR.	Purple Finch	M.WV.
Tennessee Warbler	M.	Pine Grosbeak	WV.
Orange-crowned Warbler	O.M.	Hoary Redpoll	A.
Nashville Warbler	M.	Common Redpoll	WV.
Parula Warbler	O.M.	Pine Siskin	M.WR.
Yellow Warbler*		American Goldfinch*	PR.
Magnolia Warbler	M.	Red Crossbill	M.WV.
Cape May Warbler	M.	White-winged Crossbill	M.WV.
Black-throated Blue Warbler	M.	Green-tailed Towhee	A.
Myrtle Warbler	M.O.WV.	Rufous-sided Towhee	WV.
Black-throated Green Warbler	M.	Savannah Sparrow*	
Cerulean Warbler*		Grasshopper Sparrow	O.SR.
Blackburnian Warbler	M.	Le Conte's Sparrow	A.
Chestnut-sided Warbler	M.	Henslow's Sparrow	O.SR.
Bay-breasted Warbler	M.	Sharp-tailed Sparrow	O.M.
Blackpoll Warbler	M.	Vesper Sparrow*	
Pine Warbler	O.M.	Lark Sparrow	A.
Prairie Warbler	O.M.	Slate-colored Junco	M.WV.
Palm Warbler	M.	Oregon Junco	O.WV.
Ovenbird*		Tree Sparrow	M.WV.

Species	Status	Species	Status
Chipping Sparrow*		Lincoln's Sparrow*	O.
Field Sparrow*	also O.WV.	Swamp Sparrow*	M.O.WV.
White-crowned Sparrow	M.O.WV.	Song Sparrow*	PR.
White-throated Sparrow	M.O.WV.	Lapland Longspur	WV.
Fox Sparrow	M.WV.	Snow Bunting	WV.

i. Bald Eagle

A single mature Bald Eagle was seen in Caistor Township, Concession I, Lots 14 and 15, on August 30, 1970. This is an interesting record, as the great majority of Bald Eagles in Canada are now seen on the Vancouver Island shores and farther north in British Columbia. In Eastern Canada, Bald Eagles have declined in numbers in recent years, apparently the victims of pesticide residues.

b. Wildfowl Habitat

It was found from examination of the aerial photographs of the Niagara region that there were several thousands of small potholes, apparently filled with water in spring. These occurred chiefly in Wainfleet Township both north and south of Forks Creek, but south of the Welland River. Some potholes were also found in woodlots in the former Moulton, Sherbrooke and St. Catharines Townships. Many of the potholes were visited during the summer of 1970 and found to be dry. A very few remained as pools and these contained aquatic vegetation useful for wildfowl, such as *Lemna* and *Spirodela* (Duckweeds).

At the four weather stations in the region, the precipitation for each month during the survey was compared with the mean monthly precipitation over the total period during which data have been recorded. This led to the conclusion that the summer of 1970 was considerably wetter than normal in each month except May (drier than normal). It can therefore be further concluded both from the above data and from field examination that the great majority of potholes are normally dry in summer and do not support aquatic vegetation.

Of the three major wetlands (Wainfleet, Humberstone and Willoughby) the Wainfleet bog is very much the largest. The vegetative cover of this peat bog is mainly low Blueberry (*Vaccinium* sp.), broken by patches of Poplar. Around the north, west and southern edges there is a dense stand of young Poplar and Willow (*Salix* sp.). In the centre of the bog there is a small area of Highbush Blueberry (*Vaccinium corymbosum*) growing up to seven feet in height. There is reported to be an island of Tamarack (*Larix* sp.) in the south central sector.

The bog is owned by a company which cuts peat, and much of the centre of it has been worked over for this purpose for many years. The company has drained much of the bog by cutting ditches in order to allow equipment to be used on it. The bog therefore tends to be dry during the greater part of the summer, and virtually no waterfowl use it except as a resting area in spring and fall.

Waterfowl were present in small numbers or in single broods in many parts of the watershed, particularly along the Welland River. The following three areas appeared to offer good conditions now and to have potential for improvement: Mud Lake, north of Port Colborne; Lyons Creek, in the former Crowland Township and a small pond north of Mud Lake, east of Highway 58.

i. Mud Lake

Mud Lake is located in Concession IV, Lots 27 and 28 in the former Township of Humberstone. When full, the lake is approximately half a mile in length and up to a quarter of a mile in width.

It is bounded to the north, west and south by earthen dikes which retain the



If properly managed, Mud Lake would provide an attractive area for migrating waterfowl.



*Lyons Creek's broad, shrubby flood plain is created by the meandering nature of the stream.
The Lyons Creek area contains the finest Wood Duck habitat in the Niagara region.*



water body. The soil is clay and all water in the lake is derived from runoff from the east. A silty layer of soft ooze occurs throughout all of the lake area and reaches four feet in depth in places. The ooze is underlain by a firm bottom.

Summer maximum depths reach 12 inches in the deepest portions of the two pondings that exist in dry periods. In spring and autumn the water area is increased by at least one hundred per cent and depth increases to about three and one-half feet. It appears possible that water drains *into* the marsh in spring and in the fall through the culvert marked on a map in the appendix, and drains *out* during the early summer.

At the time of the survey, large stands of *Typha* had died back on the southern margins of the lake. No reasons for the die-offs were determined.

The dike banks are wooded with thick stands composed mainly of dogwood, sumac, chokecherry, wild grape, elm, poplar and willow.

Other plant species are indicated in the appendix.

Birds sighted during the early 1970 summer survey were Black Tern, Coot, Florida Gallinule, Mallard, Teal, Green Heron and Bittern. Four broods of Mallards contained offspring which numbered 2, 9, 6 and 5 ducklings respectively. On October 3, 1970, there were present about 16 Green-winged Teal, 10 Mallards and a few individual wading birds.

Muskrats were present in sufficient numbers to attract at least one trapper during the winter.

Several duck blinds dot the area, indicating that waterfowl do make migratory stops in this marsh, but the seven blinds also indicate the chronic shortage of inland waterfowl shooting in this part of the Niagara region.

The area is now under management by the Department of Lands and Forests.

ii. *Lyons Creek Area*

Located immediately east of Cooks Mills and lying south of the road south of County Road 27, the prime areas for wildfowl production and use lie between Cooks Mills and County Road 98 in the former Crowland Township.

The creek meanders through a wide flood plain situated in moderately sloping topography. Water seems to be of good quality, but is slow and warm enough to support a fish population of bass and other warm water fishes.

Because the flood plain is so broad, the creek loses its identity in boggy areas where aquatic shrubs dominate the vegetation. The slopes to the north and south of the creek are covered with scrub, woodland and cultivated fields, but the margins of the river are for the most part wooded in a narrow band on each side.

Most of the important aquatics are indicated on a map in the appendix. However, species of incidental importance do occur in association with the emergent aquatics. Most notable in this regard is *Cornus*, which appears commonly in many shallow water and saturated soil locations along the creek.

Cephalanthus occidentalis, very important due to its excellent form, contributes significantly to Wood Duck brood habitat. It occurs mainly on the eastern half of the area.

Bordering the creek margins is a patchwork of fields, scrubland, and mixed forest in various successional stages.

Due to the slow-moving nature of the creek and its tendency to diffuse in heavily overgrown areas, this watercourse provides excellent habitat for waterfowl, especially Wood Ducks. Mallards were seen in the central part of the area during the summer survey. Prime Wood Duck brooding cover is available in the form of woody emergent growth. Heavy localized growths of *Lemna* provide good sources of food for Wood Duck broods. Adjacent agricultural land supplies additional fertility through fertilizer

applications which add materially to waterfowl food production by way of runoff.

iii. Pond North of Mud Lake, Concession V, Lot 23 (former Humberstone Township)

This shallow pond of about four acres had dense vegetation of the two major types of Pondweed (*Potamogeton*) and additional stands of Arrowhead (*Sagittaria*). When examined on August 31, 1970, there were 91 ducks on the pond including 50 assorted Black Ducks and Mallards and 41 Teal. The pond was very shallow and a large number of the ducks were feeding on the Arrowhead tubers.

The Pondweeds, which are among the most important foods for wildfowl, have been arbitrarily separated into two groups. *Potamogeton*¹ which is shown on the drawings as Po¹, includes those Pondweeds which are either Sago Pondweed (*Potamogeton pectinatus*) or which bear a strong resemblance to this species. In such Pondweeds the leaves are thread-like or ribbon-like and submersed and the seeds, stems, leaves and tubers are all eaten at times by wildfowl. *Potamogeton*² or Po² on the drawings, includes all other species or hybrids of Potamogetons. Some of these have floating leaves which are not attractive to wildfowl, although the seeds are commonly eaten. The separation of these species is not always easy since Pondweeds tend to hybridize freely. The main separation has therefore been that *Potamogeton*¹ is always attractive to wildfowl while *Potamogeton*² is less attractive.

3. Mammals

The following list includes those mammals which have been recently collected or observed in or near the Niagara region and other species which, from their general range, are considered to be certainly present. The arrangement and terminology of the list follow those of Peterson's work on the mammals of eastern Canada.* Where there was doubt about the range of a mammal the above-mentioned work was also consulted.

Where the name is preceded by "X" a specimen exists from the region in the collections of the Royal Ontario Museum. If the name is preceded by a "Y" a nearby specimen has been reported or collected.

List of Mammals

Common Name	Scientific Name	Remarks
X Common Opossum	<i>Didelphis marsupialis</i>	Local specimens frequently are frost-bitten on the ears and tail.
Y Common Shrew	<i>Sorex cinereus</i>	Probably common.
Y Smoky Shrew	<i>Sorex fumeus</i>	Less common than the preceding species.
Y Pygmy Shrew	<i>Microsorex hoyi</i>	
X Big Short-tailed Shrew	<i>Blarina brevicauda</i>	A very common shrew.
Y Little Short-tailed Shrew	<i>Cryptotis parva</i>	Found chiefly on the shore of Lake Erie.
X Hairy-tailed Mole	<i>Parascalops breweri</i>	Seldom seen, but certainly occurs in the region.
X Star-nosed Mole	<i>Condylura cristata</i>	Probably common.
X Little Brown Bat	<i>Myotis lucifugus</i>	Probably the commonest bat in Ontario.
X Eastern Long-eared Bat	<i>Myotis keenii</i>	
Y Least Bat	<i>Myotis subulatus</i>	Recorded near Hamilton.
Y Silver-haired Bat	<i>Lasionycteris noctivagans</i>	A migratory species.
X Eastern Pipistrelle	<i>Pipistrellus subflavus</i>	Recorded near St. Catharines.

* Peterson, Randolph L., *The Mammals of Eastern Canada*, Oxford University Press, Toronto, 1966.

List of Mammals ² continued

Common Name	Scientific Name	Remarks
Y Big Brown Bat	<i>Eptesicus fuscus</i>	The common bat in or around buildings.
X Red Bat	<i>Lasiurus borealis</i>	Migrates through the region.
Y Hoary Bat	<i>Lasiurus cinereus</i>	A migratory species.
Y European Hare	<i>Lepus europaeus</i>	Common.
X Cottontail	<i>Sylvilagus floridanus</i>	Abundant in 1970.
X Eastern Gray Squirrel	<i>Sciurus carolinensis</i>	Very common in 1970.
X Red Squirrel	<i>Tamiasciurus hudsonicus</i>	Common.
X Woodchuck (Groundhog)	<i>Marmota monax</i>	Abundant in 1970.
X Eastern Chipmunk	<i>Tamias striatus</i>	Very common along the escarpment.
X Eastern Flying Squirrel	<i>Glaucomys volans</i>	Recorded from near Niagara Falls.
X Deer Mouse	<i>Peromyscus maniculatus</i>	Common.
X White-footed Mouse	<i>Peromyscus leucopus</i>	Common.
X Meadow Vole	<i>Microtus pennsylvanicus</i>	In its peak years, probably the commonest mammal in the region.
X Pine Mouse	<i>Microtus pinetorum</i>	
X Common Muskrat	<i>Ondatra zibethica</i>	Common in the region in 1970.
X Norway Rat	<i>Rattus norvegicus</i>	Common in inhabited areas.
X House Mouse	<i>Mus musculus</i>	Common in houses.
Y Meadow Jumping Mouse	<i>Zapus hudsonius</i>	Common in meadows.
X Porcupine	<i>Erethizon dorsatum</i>	One specimen from Beamsville.
X Brush Wolf	<i>Canis latrans</i>	One record near Wainfleet.
X Red Fox	<i>Vulpes vulpes</i>	A fairly common species.
X Gray Fox	<i>Urocyon cinereoargenteus</i>	Many specimens from the region.
X Raccoon	<i>Procyon lotor</i>	A common species in the region.
Y Ermine	<i>Mustela erminea</i>	None seen in 1970.
X Long-tailed Weasel	<i>Mustela frenata</i>	None seen in 1970.
X Mink	<i>Mustela vison</i>	Along watercourses, scarce.
Y Striped Skunk	<i>Mephitis mephitis</i>	Common in 1970.
X White-tailed Deer	<i>Odocoileus virginianus</i>	Several were seen in 1970.

The only probable additional species is the Badger (*Taxidea taxus*), a species of southern distribution. Specimens have been collected near the shore of Lake Erie. The nearest collected specimen came from in or near Norfolk County, not far from the region.

4. Game

a. Hungarian Partridge

The prime species of game in the Niagara Peninsula is the Hungarian Partridge, but these are found in huntable populations only in the open farming areas on clay soils south and west of Smithville, in the new Township of West Lincoln. Unfortunately this population has been drastically reduced during the last four years and although the reasons are not apparent,

hunting may be a factor. In the rest of the region "Huns" are generally scarce or absent.

b. European Hare

This species is well distributed in the open lands of the region, and seems well able to take care of itself, in spite of intensive hunting pressure.

c. Cottontail

The cottontail is common wherever there are woodlots or well established hedgerows, with low cover and tangles of weeds and briars. There are still a great many such areas in the Niagara region.

d. Ruffed Grouse

Grouse were flushed in several woodlots during the survey of 1970. These tended to be woodlots with mixed hardwoods and coniferous growth, particularly where young aspen trees are common. The species is still a fairly common game bird of the region.

e. Woodcock

Woodcock are breeding birds of the region in grassy alder swales and on the edges of woodlands which have been lightly grazed and which have damp soil with an abundance of worms and insects, the chief foods of the Woodcock. They are found in much greater numbers in the peninsula during migration.

f. Pheasants

The Ring-necked Pheasant occurs in small numbers in the region as a permanent resident, but according to reports most of those which overwinter in the region have access to some form of artificially supplied winter food. The temperature in winter is not a limiting factor. (Pheasants survive in the Peace River district in Alberta, which has extremely low winter temperatures.) The main limiting factors in Southern Ontario is the maximum depth of snow, and the occurrence of sleet storms forming ice on food supplies. In recent years, with co-operation of the St. Catharines and Lincoln County Fish and Game Club, large numbers of day-old pheasants have been given to farmers in Lincoln County who were paid to raise and release them (when grown) for hunting during the fall. These pheasants have come from the Normandale hatchery. The project has been very successful in providing immediate hunting, but few of the birds survive the winter.

g. Deer

While deer are common in suitable habitat, particularly around marshes and away from the urban centres, there was no hunting of deer permitted in the peninsula in 1970.

5. Flora

The area with the greatest variety of species of vascular plants in the whole of Ontario is probably the St. Johns Conservation Area, north of Fonthill. This is because there is a great variety of soils and moisture conditions in the area and there is therefore a remarkable mixture of plants from both the Transition Zone of vegetation and the Carolinian Zone. A typical example of this difference is the occurrence of the clubmoss *Lycopodium lucidulum* (Shining Clubmoss) a more northern species, and the Sassafras and Tulip Tree, both more southern species.

A list of 324 species of plants found in the area has been prepared by the Niagara Falls Nature Club. It appears that ferns, clubmosses and orchids interest the general public more than most other species of plants. Included here are the representatives of these three families which occur in the St. Johns Conservation Area.

Fern Family

Fragile Fern – *Cystopteris fragilis*

Ostrich Fern – *Pteretis pensylvanica*

Fern Family *continued*

Sensitive Fern – *Onoclea sensibilis*
Marsh Fern – *Thelypteris palustris*
Broad Beech Fern – *T. hexagonoptera*
New York Fern – *T. noveboracensis*
Marginal Wood Fern – *Dryopteris marginalis*
Spinulose Wood Fern – *D. spinulosa*
Christmas Fern – *Polystichum acrostichoides*
Lady Fern – *Athyrium filix-femina*
Silvery Spleenwort – *A. thelypteroides*
Maidenhair Fern – *Adiantum pedatum*
Bracken – *Pteridium aquilinum*
Royal Fern – *Osmunda regalis*
Interrupted Fern – *O. claytoniana*
Cinnamon Fern – *O. cinnamomea*
Rattlesnake Fern – *B. virginianum*

Clubmoss Family

Tree Clubmoss – *Lycopodium obscurum*
Shining Clubmoss – *L. lucidulum*
Running Pine – *L. complanatum*

Orchid Family

Large Yellow Lady's Slipper – *Cypripedium calceolus*
Round-leaved Orchid – *Habenaria orbiculata*
Helleborine – *Epipactis helleborine*
Nodding Ladies' tresses – *Spiranthes cernua*
Slender Ladies' tresses – *Spiranthes gracilis*
Spotted Coralroot – *Corallorhiza maculata*
Bog Twayblade – *Liparis loeselii*

Two interesting species have been introduced to the area. These are the Pitcher Plant (*Sarracenia purpurea*) and the Round-leaved Sundew (*Drosera rotundifolia*), both of which are insectivorous. These are almost certainly the only insectivorous plants in the peninsula.

6. Ratings for Wildlife Under the Canada Land Inventory

The Niagara Peninsula has been surveyed on a rather broad scale for its wildlife potential as a part of the Canada Land Inventory, which is the basic data-gathering arm of The Agricultural Rehabilitation and Development Act (ARDA). The actual work, which is largely federally-sponsored, was carried out by the Ontario Department of Lands and Forests.

The species primarily involved here included deer, pheasants, European hare, Hungarian partridge, geese and wildfowl (puddle ducks). The land capability was based on the inherent ability of land or water to produce food and cover. The effects of climate were also considered, but present land use was not. The ratings indicate levels of game populations and production possible only when the land or water is managed to produce the best quality of habitat. The "degree of effort" required to transform an area into its best capability for wildlife was rated in five classes. This information is available to the Authority from the Department of Lands and Forests when required for comparison of sites for wildlife projects.

Section 7

QUALITY OF THE NATURAL ENVIRONMENT

Natural beauty and wonder are priceless heirlooms. How shall we escape the contempt of the coming generations if we suffer this irreplaceable heritage to be wasted?

— *Henry Van Dyke*

1. Recreation Resources

Within the area under the jurisdiction of the Niagara Peninsula Conservation Authority, areas of unusual natural beauty are abundant. However, if the current rate of attrition continues, many of these irreplaceable resources will certainly be lost to future generations.

From the point of view of the landscape, the main features which make up its recreational base may be summarized as four linear regions: The Great Lakes shoreline, the Niagara Escarpment, the Welland Canal and the inland stream valleys — all of a significant nature in that the recreational landscape can offer potential for varying types of active and passive leisure-time activity.

The location of the Niagara Peninsula between the major urban complexes of Buffalo-New York and Toronto-Hamilton — containing one of the most heavily used transportation routes between the United States and Canada — places it under perhaps the most severe development pressure of any area in Ontario. Its accessibility has resulted in much of the recreational base (especially the shoreline) having passed into private hands. The result has been a situation in which public access to the shoreline is well below a desirable level.

The recreational quality of the area has in the past largely been taken for granted with emphasis revolving around the Niagara Falls focus. One of the undisputed wonders of the natural world, its magnetism has overshadowed all else in the vicinity. As a generator of tourists' visits to the Niagara-Iroquois Vacation Region it leads all others in Ontario and is second only to the Metropolitan Toronto Region as a tourist revenue producer.

Capitalizing to a large degree on Niagara Falls, the Niagara Parks Commission holdings from Niagara-on-the-Lake to Fort Erie have become recreational attractions in their own right as have numerous historic sites and buildings, among which Fort George and Fort Erie are now administered by the National Historic Sites Branch. In the area of cultural landscape features the Welland Canal in its successive stages is a major recreational attraction. Within the current holdings of the St. Lawrence Seaway Commission, along the length of the canal, exists an open space corridor of considerable variety and recreational potential. Greater utilization of this resource will require a comprehensive development plan probably under multi-agency direction.

The Authority area may be divided into four broad physiographic areas each possessing natural features and environments particularly suited to outdoor recreational activities. Examples of these features and environments should be protected from further incompatible developments as soon as possible. These four main areas are the Niagara Escarpment, the clay plain, sand and gravel deposits, and the glacial Lake Iroquois Plain.

The predominant and most important feature is, of course, the Niagara Escarpment. From Tobermory southwards across Ontario and into the United States, this "spine" of the province has gained wide renown. That portion lying within the Niagara Authority (consisting of a virtually unbroken scarp, rising in places 300 feet above the old Lake Iroquois shoreline) is one of the most scenic sections of the entire escarpment. Magnificent views over Lake Ontario and the "fruit belt" may be had from promontories along the brow. The escarpment itself dominates the visual and aesthetic quality of the landscape. Many streams and rivers flow over the escarpment forming dramatic "punch-bowls" and gorges, the most

impressive of which is Niagara Falls. Other extremely picturesque examples are found at Rockway Falls and Ball's Falls.

The clay plain covers most of the Niagara Peninsula south of the escarpment. It is mainly a flat, relatively uninterrupted landscape, trisected by two large meandering streams: Twenty Mile Creek, and the Welland River. These rivers offer some topographic and visual relief. While this area offers least in recreational possibilities, a few small areas would be valuable in providing recreational facilities such as access to the rivers, picnic areas, and highway rest stops.

The third large physiographic area is in fact made up of a number of smaller areas formed by fluvio-glacial action and consisting mainly of sand and gravel deposits.

A large sand deposit covering most of Moulton Township and the north-west section of Wainfleet Township extends to the shore of Lake Erie. Other sand and gravel deposits are found elsewhere in the Authority area, the most significant being the Fonthill kame, better known as the Short Hills. At one time this was a river valley eroded through the escarpment, but during the last glacial period the re-entrant was covered by a large moraine. Flowing water has dissected the area to make it one of the most spectacular landscape regions in the Authority. Residential development is now occurring in the Short Hills area. The St. Johns Conservation Area is in this section and a provincial park has been proposed.

The fourth significant physiographic area is that lying between the escarpment and Lake Ontario, the glacial Lake Iroquois Plain. Owing to a unique combination of climate and soils this area has become world famous for the production of tender fruits such as peaches and cherries. The orchards in this area contribute a seasonally changing vista highlighted by the magnificent spring blossom display. In addition to the agricultural arguments for preserving this area from further urban development, certain areas of orchard should be preserved for their aesthetic quality which may be particularly appreciated from vantage points along the escarpment.

Other smaller physiographic units such as the marshes of Humberstone and Wainfleet Townships are unusual in the authority area and have the potential to provide recreational activities such as hunting, hiking, snowmobiling and cross-country skiing as well as natural history or ecological studies.

2. Destructive Factors

Subdivisions are crowding in on the scenic features of the Niagara Peninsula. Large numbers of these proposed developments are located on lands which have less than the best characteristics and capabilities to withstand urban development.

The physical problems related to urban development in the Niagara Peninsula can be defined in three categories: 1) shoreline, 2) river valley and watercourse and 3) Niagara Escarpment area including talus slopes, terraces and swampy areas underlain by limestone.

Urban development in the Niagara Peninsula has been administered, to date, by the local municipalities under provisions of The Planning Act and The Municipal Act. Lands which were advantageous for development were developed first. For example, the "fruit belt" lands presented virtually no physical obstacles for development. They were relatively well drained and needed no great physical improvements. Krueger in his studies of the Niagara "fruit belt" has indicated that trends which were established in the late 1950s have continued to the present.

The remaining natural features which should be protected to provide recreation and Open Space benefits generally possess difficult physical problems to overcome for urban development. Therefore the watercourses, river valleys, escarpment lands and shoreline areas will assume new importance in the design and development of urban areas.

In the past, municipalities have been able to acquire five per cent of subdivision lands for Open Space purposes under The Planning Act. The Planning Act however provides that

municipalities may choose to accept cash in lieu of land or that they may sell lands acquired under The Planning Act provided that the approval of the Minister of Municipal Affairs is obtained and that the monies so gained, less the costs incurred, are placed in a "special account" set up to purchase and improve public lands. The Niagara Peninsula Conservation Authority should be aware of the municipal processes related to subdivision development and approval and provide consultation and advice to the municipalities in the selection of lands required for Open Space purposes. Lands which are unsuitable by reason of their inherent natural hazards such as steep slopes or susceptibility to erosion and/or flooding, should be set aside permanently.

The shoreline areas of the Niagara Peninsula Conservation Authority are susceptible to extreme erosion especially on Lake Ontario. It is imperative that long-term studies and physical remedial works be carried out to control erosion along the shorelines.

Urban development adjacent to ravines may add increasing sediment loads to the watercourse particularly during the construction phase. The construction site is susceptible to erosion between the period of land clearing and shaping and the final stabilization of the new surface. Erosion control during this period is necessary if the lasting effect of these sediments on the downstream aquatic environments and the channel shape is to be minimized.

The importance of the natural environment to the social well-being of residents cannot be too greatly stressed. Of equal importance are the extra-regional impacts of the Niagara Peninsula environment. Specifically, the Niagara Peninsula serves as a gateway to tourists from the United States and provides a setting which is enjoyed by many thousands of Ontario residents during the annual spring blossom period. Loss of the unique natural environmental systems within the Niagara Peninsula Conservation Authority will reduce the present and future enjoyment of the area.

Under The Pits and Quarries Control Act, 1971, a provincial permit is required for all new pits or quarries. Fill and Construction Regulations established and enforced by the Niagara Peninsula Conservation Authority could augment this environmental control by protecting the ravines, watercourses, talus slopes and the Niagara Escarpment face from urban development.

PART THREE

SOCIAL AND ECONOMIC DEVELOPMENT

Section 8

HISTORICAL DEVELOPMENT

Niagara Falls had been a landmark for unknown numbers of voyageurs and explorers for at least fifty years when the first recorded first-hand impression of them was made by the famous French missionary, Louis Hennepin, on December 6, 1678. Between the lakes, he wrote, “there is a vast and prodigious Cadence of Water which falls down after a surprising and astonishing manner, so much so that the Universe does not afford its Parallel.”

Seventy years later, Chabert Joncaire constructed a mill dam by the Falls in an attempt to turn the power of the water to account by driving mills to produce timber for building ships at the site and therefore give the French command of the Lakes.

Because of Niagara’s strategic position in relation to fur-trading routes, the French maintained trading and garrisoned forts there until the fall of New France, when the garrisons in turn became British.

A quarter of a century later, after the American Revolution, Niagara became again, as it had been during the French period, a political frontier post. Settlement was rapid. A survey of August 25, 1782, recorded that 17 families were then cultivating 236 acres of land and possessed livestock of 49 horses, 61 cattle, 31 sheep and 103 pigs. The next year, 258 discharged soldiers from Butler’s Rangers took grants of land and, according to a census taken in June, 1785, Niagara then had 770 inhabitants.

Their numbers increased with the arrival of farmers from the United States who in many cases bought land from soldiers who found farming not to their liking. With government encouragement and grist and saw mills practically from the beginning of settlement, the community quickly passed beyond the stage of pioneer outpost that was to be typical of areas along much of the Lake Ontario front until the early decades of the nineteenth century, and the principal centre, Niagara (then Newark) was for a time the capital of the new province.

The peninsula’s farmers, like their counterparts in the eastern settlements, concentrated from the first on growing wheat – initially for supplying the army garrisons and the fur-trading North West Company – a practice that continued, despite drawbacks resulting from changes in international markets and trading acts and from rust, the Hessian fly and the wheat midge, through the first half of the nineteenth century. To supply the demand from Lower Canada, what were commonly known as “merchant mills” were built within the first generation of settlement. Below St. Johns, for instance, there was in the first half-decade of the nineteenth century, one such mill that was four and a half storeys high and had two pairs of stones as well as fanning mills.

From the late 1820s, with the opening of the original Welland Canal that was intended to both facilitate Canadian trade and draw the American trade into the provinces, the peninsula was also known for a number of commercial sawmills that helped supply pine timber for international markets and, from about 1850, sawlogs and hardwoods for the States.

After the Imperial Corn Act of 1843, considerable amounts of American wheat were brought into the province to be ground and exported as Canadian flour, and for several years there was a great increase in forwarding and milling facilities along the canal.

By 1851, the Niagara Peninsula was well known for the profitability of its agriculture. One informed comment of the time by an American visitor, was that: “Some of the most beautiful farms I ever saw were situated on the Canadian side of the river from Buffalo to Niagara.” The keeping of livestock and the growing of fruit were sidelines during the first part of the nineteenth century by comparison with the production of wheat. Very little land was given over to such feed crops as hay and turnips, and an observer in the Niagara region

wrote that it was "a pitiable sight to go around the country and see the multitudes of poor cattle which fill almost every farmer's yard in the spring." From the late 1840s, however, more care was given to proper feeding and quality of breeds as a result of an expanded market in the Northern States. From the 1850s there was as well a demand for Niagara horses, particularly roadsters.

Peaches, apples, and lesser quantities of other fruits were shipped by Niagara farmers to places east from about 1815 onwards, but it was not until the 1850s when railways made transportation easy and wheat-growing began to seem less attractive, that the trade in fruit really became significant. In 1859 the Niagara district's fruit production was estimated at 30,000 barrels, and peaches, plums, grapes, pears and apples went not only to Toronto and Montreal but also to New Brunswick, the States and Britain. In the same year a Niagara Fruit Growers' Association was formed, although it was still rare for a farmer to concentrate exclusively on fruit-growing.

Vulnerability of, for example, plum trees to black knot and curculio, pear trees to fire blight, and apple trees to the codling moth, the treeborer, and bark louse, also affected the willingness of farmers to devote all or most of their time and resources to fruit-growing.

Successful marketing and full realization of the peninsula's climatic advantages made all the difference from the 1860s. The British market for apples increased so rapidly that, by 1880, the Canadian and competitive American produce together accounted for most of what was sold in British cities. Although smaller than the American, Canadian apples were said to be hardier and therefore better keepers. The quantity exported was estimated by 1879 to have increased twelve times over during the decade, and was then valued at about three hundred thousand dollars annually from the province as a whole. In addition, about fifty thousand dollars worth was exported to the U.S. The Baldwin was by far the favourite for these markets.

Peaches were the next most important fruit crop at the time. Apart from the disease known as yellows, which destroyed a large number of orchards in the mid-1870s, there were few hazards in peach-growing. Markets were mostly in Ontario and in the Northern States after the American season was over. In 1880 it was "roughly calculated that one thousand five hundred acres are under cultivation as peach-orchards in the Niagara district, the number of trees being three hundred and seventy-five thousand, and their produce a million baskets of fruit annually." A number of peach canning factories were established locally and others at Toronto processed Niagara fruit.

Uncertainty about climatic effects prevented large-scale growing of grapes until the second half of the nineteenth century. With the organization of the Vine Growers' Association in 1866, which supplied both informational and marketing facilities, viticulture became widespread below the escarpment. Grape rot made a difference at times, but during the following decades thousands of baskets of grapes were shipped each year to Toronto and other Ontario centres. The Concord was the favourite market grape, and the late-ripening Isabella replaced it towards the end of the season. The Clinton was preferred by most local winemakers, although Catawbas were grown on Pelee Island and sold in the Niagara Peninsula for making wine.

Fruit-growing nevertheless remained part of mixed farming practice that included dairying and the supply of milk to cheese and butter factories as well as liquid milk distribution and still, on a reduced but sizeable scale, wheat-growing until well after Confederation. From approximately 1890, Niagara fruit-growers increased their production of peaches, pears, plums and cherries and reduced apple orchard acreage as a result of competition from British Columbian and Nova Scotian growers.

This has remained the pattern, with the Niagara region responsible by the 1950s for

more than half of Ontario's fruit production and more than a quarter of the national production.

In the 1960s the area was estimated to produce 73 per cent of the nation's peaches, 57 per cent of the plums, 53 per cent of the pears, 47 per cent of the cherries and 99 per cent of the grapes.

Fruit acreage grew noticeably until the latter part of the 1950s. By 1961, 90 per cent of commercial farms on the Iroquois plain were classed as fruit and vegetable farms.

From 1957 to 1961, the average annual production of grapes was 45,000 tons. In the period 1961 to 1965 this increased to 55,000 tons, worth an average annual \$5,000,000. The Concord, a wine, juice and eating grape, has remained the main variety produced, but a considerable number of hybrids and special purpose grapes have obtained increasing markets in the past decade.

Dairying has continued to be important along the escarpment and in Haldimand County. Hay, oats, wheat and corn have been the main crops.

Industries have naturally established themselves along the Welland Canal, from its earliest form in the 1820s to its latest as part of the St. Lawrence Seaway. Lumbering on the Welland River, with rafts towed up the Niagara to Tonawanda has given way to major pulp mills at Thorold that were giants of their kind when built in 1912 by the Ontario Paper Company to feed the Chicago market with Ontario pulp wood. Woollen mills at Allanburg, Thorold and St. Catharines were similarly out-dated by cotton textile mills and the importation of cloth from the United States. In the 1850s, iron works at Chippawa and St. Catharines produced boilers and steam engines for varied purposes, including sawmills and fire engines. Today, St. Catharines produces machinery as well as auto parts, electrical and hardware goods. At Port Colborne one of the provinces's largest flour mills was built early in the present century. Nickel is also processed there, and a chemical industry has been established at Niagara Falls. Welland, a village in 1858 and now third in size in the region to Niagara Falls and St. Catharines, has had considerable industrial growth in the present century in metals-processing, ship-building and a number of other enterprises.

Power plants have greatly affected industrial activity. Hydro-electricity was first generated on the Canadian side of the Falls in 1895 and the first plant was in full operation three years later. In 1903 a provincial commission examined the supply and distribution of power and in 1908 an agreement was concluded with the Ontario Power Company for supplying electricity up to a maximum of 100,000 horsepower (equivalent to 134,100 Kilowatts).

The use of electricity by municipalities increased rapidly within a few years. In St. Catharines, for example, there were, in mid-1916, 43 power customers, 226 commercial users and 2,088 domestic customers.

With the formation of the Hydro-Electric Power Commission in November, 1922, a central authority was established to meet the problems that came with expanding supply and demand.

Today the Sir Adam Beck generating stations situated some six miles below the Falls, constitute one of the most developed sources of hydro-electricity in the world. Total kilowatt power for the several generating stations on the Niagara, and De Cew Falls on the Welland Canal, was 2,251,230 in 1969.

The Nanticoke thermal generating plant, just west of the Niagara region was planned at the end of the 1960s to have four units in service by 1974, for a total capacity of 2,000,000 kilowatts.

The Falls were a recognized tourist attraction in the early 1830s when prevailing opinion, as stated by Andrew Reed and Thomas Matheson, was that Niagara should be "deemed the property of civilised mankind." Fifty years later, in 1885, the Ontario Legislature passed an Act "for preservation of the Natural Scenery about Niagara Falls," which

provided for a board of three commissioners to select on the public behalf lands that would help preserve "as far as possible what still remains of the natural and original." They were as well to "endeavour to restore those portions of the ground on and near the bank of the river . . . which have been denuded of trees, and are now occupied by a variety of buildings . . . to as near their natural condition as possible, by planting trees and otherwise," and to "afford to travellers and others facilities for observing the points of interest in the vicinity." The first park — Queen Victoria Park — was established in 1887 and, after general restoration of the area in the final decade of the nineteenth century, the Ontario Power Company became the main source of financing the maintenance of lands that eventually extended beyond the immediate area of the Falls:

Today, of course, Niagara Falls is one of the world's major tourist attractions, visited by millions annually.

Section 9

GENERAL DESCRIPTION

1. Population Characteristics and Projections

The greatest concentration of population is found in the north-east portion of the Authority area. Of the counties in the Authority, Lincoln County experienced the fastest population growth between 1951 and 1966 (64 per cent). This growth rate is related to the location of Lincoln County along an axis of rapid growth. As with other areas of the province, two trends are occurring: first, population is being concentrated in urban centres and second, rural non-farm population is increasing in those areas accessible to major urban centres. The second trend is not evident in the Counties of Lincoln and Welland where there has been a decrease in the rural non-farm population. This is a result of the intensification of agriculture in these counties. The reorganization of the municipalities as of January 1, 1970, recognized the trend toward urbanization and municipalities were reorganized in accordance with their abilities and responsibilities for planning. The concentration of urban activities lies in the north and north-east and is related to accessibility and suitability of land for development.

The development of urban transportation corridors related to Hamilton, St. Catharines, Welland and Port Colborne can be clearly seen when the population densities are analyzed. The impact of future industrial development in the Nanticoke Area will induce further corridors to be developed in that direction.

The urban population percentage increased in Lincoln and Welland Counties over the 1961-66 period. The Lincoln County urban percentage of population increased from 74.9 to 80.3 per cent while that of Welland County increased from 81.1 to 83.8 per cent. It is significant that the urbanization trend is continuing to lead to an expectation of even greater pressures on the land-based resources in the future. Such problems as the decrease in acreage of tender-fruit lands, erosion problems along the lake shores, coupled with the destruction of ravines and the Niagara Escarpment, are to be expected. These are the problems to which the actions of the Niagara Peninsula Conservation Authority will have to be directed.

A projection of population for the Authority area is difficult to determine due to the recent reorganization of the municipalities and the lack of regional policies to guide growth. As the new regional government assumes the planning function, municipalities will be less prone to encourage growth of population or industrial assessment to the detriment of other municipalities. The new regional focus coupled with anticipated provincial policies on regional development will do much to affect any population projection based on past trends. Suffice it to say that existing urban centres will continue to grow slowly up to the point that hard services can be provided. A slight decline in rural farm population is anticipated until the land being taken out of agriculture is balanced by an increase in the conversion of marginal land to agriculture or by intensified agricultural practices.

**Table 9-1: Population By Municipality
Niagara Peninsula Conservation Authority 1951-1970**

Municipality	1951 ¹	1961 ¹	1966 ¹	1968 ²	1970 ³
(Part within Conservation Authority)					
Ancaster, Twp.*	382	667	748	759	767
Binbrook, Twp.*	1,356	2,506	3,068	3,408	3,610
Glanford, Twp.*	2,200	4,243	5,187	5,362	5,523
Saltfleet, Twp.*	3,024	5,256	5,755	5,833	6,031
Canborough, Twp.*	776	891	1,010	1,009	993
Cayuga, N., Twp.*	438	488	385	382	434
Moulton, Twp.*	1,197	1,382	1,538	1,590	1,741
Seneca Twp.*	1,075	2,086	1,374	1,437	1,469
Sherbrooke, Twp.*	204	199	214	221	234
Haldimand and Wentworth Counties	10,652	17,718	19,279	20,001	20,802
St. Catharines, City	60,725	84,472	97,101	100,799	
Beamsville, Town	1,712	2,537	3,886	4,047	
Grimsby, Town	2,773	5,148	6,634	6,773	
Niagara, Town	2,108	2,712	3,113	3,088	
Caistor, Twp.	1,357	1,670	1,822	1,883	
Clinton, Twp.	4,075	5,825	5,815	5,643	
Gainsborough, Twp.	2,343	2,532	2,852	2,929	
Grimsby, N., Twp.	2,973	5,757	7,180	7,688	
Grimsby, S., Twp.	1,726	2,319	2,669	2,849	
Louth, Twp.	4,473	5,086	5,677	5,875	
Niagara Twp.	5,101	8,616	9,350	9,219	
Niagara Falls, City	40,603	53,365	56,891	56,851	
Port Colborne, City	12,170	14,886	17,986	18,168	
Welland City	15,382	36,079	39,960	40,315	
Fort Erie, Town	7,572	9,027	9,793	9,688	
Thorold, Town	6,397	8,633	8,843	8,842	
Chippawa, Village	1,762	3,256	3,877	4,219	
Crystal Beach, Village	1,204	1,886	1,857	2,037	
Fonthill, Village	1,412	2,324	2,790	2,937	
Bertie, Twp.	5,515	8,595	9,281	9,804	
Crowland, Twp.	12,086	1,870	2,081	1,868 ⁺	
Humberstone, Twp.	3,923	6,574	4,783	4,836 ⁺	
Pelham Twp.	3,939	4,795	5,270	5,786	
Thorold, Twp.	6,522	6,815	8,111	7,968	
Wainfleet, Twp.	3,594	4,755	5,121	5,143	
Willoughby, Twp.	1,152	1,881	2,174	2,188	
Lincoln and Welland Counties	212,599	291,415	324,917	331,443	
Niagara Falls, City					64,131
Port Colborne, City					21,261
St. Catharines, City					104,969
Welland, City					44,680
Fort Erie, Town					22,531
Grimsby, Town					15,200
Lincoln, Town					13,661
Niagara-on-the-Lake, Town					12,460
Pelham, Town					9,855
Thorold, Town					15,318
Wainfleet, Twp.					5,343
West Lincoln, Twp.					8,233
Regional Municipality of Niagara (organized January 1, 1970)					337,642
Total Population of NPCA	223,251	309,133	344,196	351,444	358,444

1. *Census of Canada, Dominion Bureau of Statistics.*

2. *Municipal Directory, 1969, Department of Municipal Affairs.*

3. *Municipal Directory, 1971, Department of Municipal Affairs.*

* *Population adjustment by area in NPCA*

+ *Annexation.*

2. Social Structure and Institutional Arrangements

The Regional Municipality of Niagara was created in response to and as a reflection of the pressures of urbanization in the Niagara Peninsula. It was established on the first day of January, 1970, and was composed of 12 area municipalities created from the municipalities of the old Counties of Lincoln and Welland. The parts of townships in the Authority and lying outside the newly established Regional Municipality of Niagara remain the same, i.e., parts of 5 townships in Haldimand County, and parts of 4 townships in Wentworth County.

The Niagara Peninsula Conservation Authority lies wholly within the Niagara (South Ontario) Development Region. The Regional Development Branch of the Department of Treasury and Economics has recently completed *Design for Development: Niagara (South Ontario) Region, Phase I: Analysis*. This report is the first of a series leading to a comprehensive program for regional development in this part of the province.

The newly created regional municipality is a two-tiered form of government whereby responsibilities are divided between two levels of jurisdiction. The local area councils are responsible for matters of local concern, while the regional council is responsible for matters common to the whole region. The regional council and the councils of the area municipalities are responsible for planning. The councils are deemed to be the planning boards, and there are provisions for the delegation of some of the powers of the Minister of Municipal Affairs to the regional municipality once the Regional Official Plan has been approved.

The regional corporation is responsible for preparing an Official Plan for the entire regional municipality by the end of 1973. The 12 new area municipalities are subsidiary planning areas whose official plans must conform with the regional municipality's Official Plan once approved by the Minister of Municipal Affairs.

The creation of a new local government framework has important implications for the Niagara Peninsula Conservation Authority. Instead of dealing with many separate municipalities with disparate local viewpoints, the Authority will be contacting an organization which has regional jurisdiction in matters of joint concern. Urban problems will be viewed from a regional perspective which may lead to greater urban emphasis.

Special purpose commissions and bodies exist and have jurisdiction in the area of the Niagara Peninsula Conservation Authority. Two such agencies are the Niagara Parks Commission and the St. Lawrence Seaway Authority. Plans and policies relating to the functions of these and other agencies may have great impact on the operation of the Niagara Peninsula Conservation Authority, and a permanent working liaison should be established with these agencies.

The urban population is not only increasing numerically but also becoming more environmentally aware. Local anti-pollution groups and other citizens committees, of which there are a number on the peninsula, have formed in response to perceived environmental problems. The Niagara Peninsula Conservation Authority should be cognizant of such public opinion groups and channel their good intentions towards positive environmental programs of the Authority.

3. Current Economic Growth Characteristics

The Niagara (South Ontario) Development Region proportion of the Ontario labour force declined from 14 to 13 per cent in the decade 1951-61. Lincoln County, however, experienced a relative increase in its proportion of the province's labour force. While there were small increases in the primary and manufacturing sectors a much larger increase was noted in the tertiary sector. *The Design for Development: Niagara (South Ontario) Region, Phase I: Analysis*, notes that the fast growth industries in Ontario were the transportation equipment, electrical products, machinery and metal fabricating groups. The machinery industries

Table 9-2: Labour Force By Industry Divisions, Counties and Province of Ontario, 1951 and 1961

		All Industries	Agriculture	Forestry	Fishing and Trapping	Mining, Quarries and Oil	Manufacturing	Construction
LINCOLN	1951	36,268	4,816	31	11	83	15,665	2,903
	%	100.0	13.3	0.1	x	0.2	43.2	8.0
	1961	46,371	4,399	11	5	84	16,813	3,140
	%	100.0	9.5	x	x	0.2	36.3	6.8
	% Change	27.9	-8.7	-64.5	-54.6	1.2	7.3	8.2
WELLAND	1951	50,310	1,908	16	4	203	24,625	3,591
	%	100.0	3.8	x	x	0.4	48.9	7.1
	1961	58,269	1,645	11	4	339	22,813	3,607
	%	100.0	2.8	x	x	0.6	39.2	6.2
	% Change	15.8	-13.8	-31.3	nil	67.0	-7.4	0.4
TOTAL, PROVINCE OF ONTARIO	1951	1,884,941	201,428	23,030	2,259	30,653	615,358	127,494
	%	100.0	10.7	1.2	0.1	1.6	32.6	6.8
	1961	2,393,015	168,775	17,935	2,185	42,660	643,284	153,866
	%	100.0	7.0	0.7	0.1	1.8	26.9	6.4
	% Change	27.0	-16.2	-22.1	-3.3	39.2	4.5	20.7

and metal fabricating industries are "basic industries"* for the Niagara region. This indicates that a potential for industrial growth exists in the area.

The agricultural sector is facing problems as a result of urban sprawl and market pressures. The tender-fruit industry is particularly susceptible to these pressures. These conflicts of land use as well as the phasing out of marginal areas of production and bringing into production new areas which are amenable to the growth of tender fruits are problems that must be solved if the peninsula is to retain its role as a producer of fruits. The combination of soil, suitability of climate and the accessibility to major urban markets in Southern Ontario indicates that there is a great potential for specialized farming. The decision to continue the production of fruit and especially tender fruit must be made quickly before the area is inundated by urban land uses.

Mining for building stone and aggregates is an essential industry but has created problems in the past. The Pits and Quarries Control Act, 1971, now provides that no pits may be opened in the escarpment area without the permission of the Minister of Mines. The rehabilitation of existing pits and quarries must also be considered in planning for this area of the province.

Recreation is an important industry in the peninsula. The location of the Niagara Peninsula in relation to existing and potential urban markets in Canada and the United States means that there is a definite potential for the growth of this industry in the region. A prerequisite is the preservation of the environmental amenities, such as the escarpment and numerous ravines, which together with the Falls, form the base for the recreation industry.

* A "basic industry" is one which exports and sells the product which it manufactures outside the region in which it is located.

Table 9-2: Labour Force by Industry Divisions, Counties and Province of Ontario - *continued*

		Transportation Communication and Other Utilities		Trade	Finance Insurance and Real Estate	Community Business and Personal Service Industries	Public Administration and Defence*	Industry not Stated
LINCOLN	1951	2,331	4,316	739		5,006	x	367
	%	6.4	11.9	2.0		13.8	nil	1.0
	1961	3,029	6,498	1,274		8,626	1,678	814
	%	6.5	14.0	2.7		18.6	3.6	1.8
	% Change	29.9	50.6	72.4		72.3	nil	121.8
WELLAND	1951	5,305	5,435	791		8,025	x	407
	%	10.5	10.8	1.6		16.0	nil	0.8
	1961	5,375	7,665	1,286		11,467	2,830	1,227
	%	9.2	13.2	2.2		19.7	4.9	2.1
	% Change	1.3	41.0	62.6		42.9	nil	201.5
TOTAL PROVINCE OF ONTARIO	1951	158,125	267,267	61,728		379,129	x	18,416
	%	8.4	14.2	3.3		20.1	nil	1.0
	1961	195,223	370,540	98,454		467,127	181,263	51,703
	%	8.2	15.5	4.1		19.5	7.6	2.2
	% Change	23.5	38.6	59.5		23.2	nil	180.8

x - no data available

*Source: Canada, Dominion Bureau of Statistics, Census of Canada, Labour Force, 1951 and 1961, (Ottawa: Queen's Printer), Table 18 and Table 15.

4. Urban Centres and Their Influence

The major concentration of urban uses in the Niagara Peninsula Authority is contained in the Hamilton to St. Catharines corridor and includes the St. Catharines-Port Colborne-Niagara Falls triangle. The wide variety of economic activity in this area is one of the strengths of the economic base of the peninsula.

The area is affected by its proximity to two centres of metropolitan influence, Toronto and Hamilton. It is also part of the transportation corridor which links New York on the east to Detroit and Chicago on the west. The Welland Canal has a very definite role to play in the area, as industries which utilize great amounts of raw materials are attracted to this water transportation route.

The transportation function utilizes large amounts of lands in the study area. The major highway transportation corridors such as the Queen Elizabeth Way from Hamilton to Niagara Falls serve to attract substantial amounts of development. The less important highways are bordered by ribbon development as a result of pressures from urbanization around the cities, towns and villages in the region.

Future large scale industrial development around the Nanticoke area, it is expected, will initially have its housing, commercial, and industrial needs provided by the existing infra-structure in the area of the Niagara Peninsula Conservation Authority. Thus new roles are expected for the established urban centres. Such roles would include dormitory, entertainment and commercial functions.

Urban sprawl has spread out from urban centres into areas which are valuable for the production of agricultural products. Particularly vulnerable are the tender-fruit lands which cannot be easily replaced. The problem is especially acute in the areas of the Hamilton to St. Catharines corridor and the St. Catharines-Port Colborne-Niagara Falls triangle. A recent report states that "The Region's past growth and future potential results from the fact that

it lies across two of these growth axes within the emerging urban complex of southwestern Ontario.”* In addition, cheap water transportation through the Great Lakes Basin could be utilized to link the region with other more distant areas. This traditionally has given the peninsula a locational advantage for industries based on the processing of bulky raw materials.

As urbanization intensifies, the orientation of the Authority programs will be modified to emphasize urban environmental management especially along the ravines, the escarpment and the shorelines.

Table 9-3: Average Personal Income By Counties and Province of Ontario 1961 and 1966

	Average Personal Income		
	1961 \$	1966 \$	Change %
Lincoln	3,807	4,901	28.74
Welland	3,758	4,565	21.47
Province of Ontario	3,825	4,686	22.51

Source: Taxation Statistics, Department of National Revenue, Taxation, 1963 and 1968, Table 5 and Table 6.

5. Changing Land Use and Controls

The census figures for 1961 and 1966 indicate that there has been a decrease of 81 farms in Welland County and 108 farms in Lincoln County. Some of this change may be due to farm consolidation, since there has been an increase of 31 in the number of farms exceeding 239 acres in size. However, there has been a corresponding increase in the number of farms under three acres in size. The net reduction in number of farms appears, therefore, to be due largely to the conversion of 7,316 acres of farmland to other, largely urban, uses. This trend indicates the need for proper planning and controls during the rapid changes which are taking place. The Authority will have to work closely with the various planning agencies to ensure that the appropriate environmental policies are applied. Controls are of two main types. Under The Conservation Authorities Act, the Authority may register regulations regarding fill, construction and alteration of watercourses. Under The Planning Act, the municipalities may exert control through official plans and zoning by-laws.

The Niagara Peninsula Conservation Authority must place a high priority on the registration of fill, construction and watercourse regulations. All rivers, creeks, watercourses, organic marshes, shorelines and the Niagara Escarpment should be protected. This is a positive action towards the achievement of better environmental control. The authority should co-operate wherever possible with municipalities including the Regional Government to give environmental advice. When the fill, construction and watercourse regulations are developed and registered, the widest possible publicity should be given to them in order that owners and other regulatory agencies may become fully aware of the regulations and their goal of environmental protection.

Priority in establishing fill, construction and watercourse regulations should be given to those areas experiencing the greatest urbanizing pressures. These priorities should be set in consultation with the regional planning officials.

Any proposed regional planning policies must be critically evaluated against their potential impact on Hazard Lands and not merely against ease of providing urban services. These are lands which possess inherent physical limitations such as poor drainage, organic

* *Design for Development: Niagara (South Ontario) Region, Phase I: Analysis*, page 23.



More careful siting of utility facilities is necessary to minimize disruption along the Niagara Escarpment.



In construction of a residential subdivision in St. Catharines, a small ravine was destroyed by careless installation of a storm sewer outfall.

soils, flood susceptibility, erosion, steep slopes or any other physical condition which could lead to deterioration of environment under various land uses. A more detailed discussion of Hazard Lands is included in the appendix for the guidance of the Authority in advising its municipalities.

The shorelines of Lakes Ontario and Erie need special attention to provide access to the water. Lake Erie is more important as a cottage area than Lake Ontario. The cottages are generally located in the new City of Welland, Town of Fort Erie and Township of Wainfleet. Cottages are owned mainly by residents of the region or by those who live just outside the area, including a large number of American owners who are mainly Buffalo residents.

6. Transportation

The Niagara Peninsula Conservation Authority is located in the midst of a transportation corridor which is served by all modes of transportation except airplanes. The Welland Canal bypasses the Niagara River and is a key link in the movement of ships and cargoes up and down the Great Lakes.

The corridor is adequately served by road and rail lines. These lines are concentrated at Welland and Thorold. The major highway is the Queen Elizabeth Way which connects Hamilton and Toronto to the Niagara Peninsula and serves to transport both goods and people. Fifty per cent of the trips on the Niagara Peninsula highways are for recreation.

The major east-west road links lie below the escarpment on lands best suited for the raising of tender fruits. Highway 8 and the Queen Elizabeth Way serve to link the small hamlets, towns and cities on the Lake Ontario Shore and serve as scenic routes particularly during the fruit blossom period. Highways 20 and 57 serve as the main roads above the escarpment connecting Hamilton with Welland and Niagara Falls.

The railroads provide access in an east to west direction and United States railroads use the corridor as the short-cut from New York to Detroit and Chicago. The CNR is below the escarpment. The fact that main lines run through the Niagara Peninsula aid the growers and exporters of goods and agricultural products to move their produce rapidly to market.

The numerous winding township and municipal roads serve as scenic roads for recreation purposes, but care will need to be taken during development to prevent the loss of their scenic value.



Residential encroachment on the flood plain of a watercourse.



Unstable shoreline banks east of Port Dalhousie eroding at a rate of five to seven feet per year.

Stabilizing shoreline banks reaching an angle of natural repose. Some protection from littoral currents is afforded by the pier at Port Dalhousie.



Section 10

AGRICULTURE AND RELATED ACTIVITY

Prior to the mid-1800s, agricultural activity in the Niagara Peninsula centered around grain and forage crops as well as livestock husbandry. The agricultural produce was primarily for local consumption; however, wheat was exported to outside areas during the early 1800s.

Fruit production became prominent within the Niagara Peninsula in the late 1800s, with the major emphasis on apple production. Later, the apple production was reduced due to competition from apple growers in other parts of Ontario and in Nova Scotia. The Niagara growers lacked sufficient marketing advantages in comparison to other apple-growing regions. Hence the Niagara fruit growers shifted their attention to soft-fruit production, as the peninsula possesses distinct advantages in climate and soil conditions over other parts of Ontario. The number of frost-free days available for soft-fruit production is important to the fruit farmer. For instance, in the Niagara Peninsula there are generally 166 days a year in Niagara Falls and 174 days a year in Grimsby that are frost-free. Consequently the Niagara region, with its early growing season and other favourable conditions, has become the main soft-fruit producing area in Ontario. In particular, peaches and cherries account for a substantial amount of the production.

Grape production in the Niagara region has greatly increased since World War II, and the increase is primarily due to the demand for improved grape varieties for wine production. Through research, grower co-operation, and the use of new grape varieties, the grape production draws the highest dollar value of all fruit production in the region today. It would appear that this trend will continue as the future of Canadian produced wines looks promising.

The presence of an early growing season in the Niagara region is also beneficial to small fruit growers and specialty vegetable producers. Much of the produce from these farms is sold either as fresh market produce or as produce suitable for processing. Within the Authority area, the market-type farms are primarily located below the Niagara Escarpment.

The varied soil types and topographical features within the Authority area have undoubtedly influenced the establishment of different types of farm operations. The fruit producing areas are, for the most part, below or adjacent to the escarpment; whereas the livestock oriented farms are found mainly in the south and south-west. In these areas the soils are generally suited for grain and forage crops which are utilized as feed rations for livestock. For the most part, these livestock operations are a portion of part-time managed mixed-farm enterprises and often yield low or negative net returns. However, some full-time dairy and beef cattle type enterprises have been notably successful.

A number of large commercial poultry farms are located within the western half of the area. The number of these farm enterprises has increased considerably in the past 10 to 15 years. Most of these operations purchase their poultry feed rations in pre-mixed quantities, hence very little crop production is carried out on the farm. The capital expenditures on these farms are concentrated in buildings and equipment. Swine operations are operated in a similar fashion.

Agricultural activity plays an important role — especially fruit production and its associated processing industries which contribute significantly to the economy. Land costs,

production costs and other related problems of agricultural production, for the Niagara region, have been documented in a number of recent studies.* Since these reports are readily available for more detailed information, this particular report does not dwell on the aspects of the previously mentioned problems.

* *Design for Development: Niagara (South Ontario) Region, Phase I: Analysis*; Regional Development Branch, Ontario Dept. of Treasury and Economics, June, 1970.

Niagara Escarpment Study Group, *Niagara Escarpment Study: Fruit Belt Report*; Regional Development Branch, Dept. of Treasury and Economics, August, 1968.

Reeds, L.G., *Niagara Region Agricultural Research Report: Fruit Belt*; McMaster University, Hamilton, Ontario, March, 1969.

Section 11

FOREST RESOURCES AND RELATED ACTIVITY

1. Extent and Nature of The Resource

The survey of local forest cover types was based upon a sampling system designed in a manner to generally traverse all physical features of the area. The results revealed no dominant species or group of species.

The principal forest cover types are listed for each township as follows, in order of frequency and area.

Table 11-1: Forest Cover Types by Township

Name of Township	10% and up	5.0-9.9%	1.0-4.9%
Bertie	Red oak Ash-hickory Red oak-basswood- white ash	White oak- black oak- red oak Sugar maple	Silver maple- white elm Willow
Binbrook	Sugar maple- basswood Beech-sugar maple Red oak-basswood- white oak Red oak Sugar maple	White oak White pine- red oak- white ash	Beech Ash-hickory Silver maple-white elm White pine
Caistor	Red oak White oak- black oak- red oak Beech-sugar maple White oak		Silver maple- white elm Ash-hickory Sugar maple White elm
Canborough	White oak- black oak- hickory White oak Red oak-basswood- white ash	Red oak Sugar maple- basswood	Sugar maple Silver maple- white elm
Cayuga (North)	White oak- black oak- hickory White oak- black oak- red oak	Beech-sugar maple Sugar maple- basswood Ash-hickory	Red oak-basswood- white ash
Clinton	Sugar maple Beech- sugar maple Ash-hickory Red oak	Beech	
Crowland	Red oak White oak Sugar maple Beech-sugar maple	Ash-hickory	Red oak-basswood- white ash Beech
Gainsborough	Red oak Beech- sugar maple White oak- black oak- red oak White oak Red oak- basswood- white ash		Silver maple- white elm Sugar maple White pine- red oak- white ash

Table 11-1: Forest Cover Types by Township - *continued*

Name of Township	10% and up	5.0-9.9%	1.0-4.9%
Glanford	Beech- sugar maple Sugar maple	Red oak Red oak-basswood- white ash Ash-hickory	Sugar maple- basswood
Grimsby (North)	Red oak Ash-hickory Sugar maple		Beech Beech- sugar maple
Grimsby (South)	White oak Ash-hickory Sugar maple Red oak Beech- sugar maple	Red oak-basswood- white ash	Sugar maple- white elm Sugar maple- basswood Aspen
Humberstone	Silver maple- white elm Aspen Red oak	Ash-hickory White oak- black oak- red oak	Sugar maple Red oak-basswood- white ash White oak-black oak- hickory
Louth	Sugar maple- basswood White elm Red oak White pine- red oak- white ash	Beech- sugar maple Ash-hickory	White oak-black oak- hickory
Moulton	Aspen Red oak- basswood- white ash Sugar maple- basswood	White elm	Ash-hickory Black ash- white elm- red maple
City of Niagara Falls	Red oak White elm Beech		
Niagara Township	Red oak Ash-hickory White elm White oak- black oak- red oak	White oak Red oak- basswood- white ash Sugar maple	Aspen
Pelham	Red oak Beech-sugar maple Sugar maple- basswood Red oak-basswood- white ash	White pine- red oak- white ash	Hemlock White oak-black oak- hickory Silver maple- white elm
Saltfleet	White oak White oak- black oak- hickory White oak- black oak- red oak Red oak-basswood- white ash Ash-hickory	Beech- sugar maple	
Seneca	Ash-hickory Sugar maple- basswood Red oak-basswood- white ash	Sugar maple White oak- black oak- hickory White pine	Silver maple-white elm White oak Red oak

Table 11-1: Forest Cover Types by Township - *continued*

Name of Township	10% and up	5.0-9.9%	1.0-4.9%
Sherbrooke	Sugar maple Ash-hickory Red oak-basswood- white ash		
Thorold	Sugar maple White oak- black oak- red oak Red oak Beech- sugar maple Red oak-basswood- white ash	Aspen	Beech Sugar maple- white elm Ash-hickory
Wainfleet	Aspen Gray birch- red maple	Red oak Ash-hickory	Silver maple- white elm Sugar maple Beech- sugar maple White oak
Willoughby	Red oak-basswood- white ash Sugar maple Red oak Ash-hickory	White oak- black oak- red oak	Silver maple- white elm

Examination of the cover-type listings for the townships indicates no dominant cover types but the greatest proportion of stands are composed of hardwoods. In particular, beech, sugar maple and basswood associated cover types contribute to the largest percentages.

Much of the forest cover has experienced considerable cutting pressure and now forest clearing for urban-type expansion is depleting many of the remaining wooded areas. It would be appropriate if the present stands in the Authority area could be maintained and properly managed.

2. Woodland Conditions

Survey observations showed the physical conditions of the woodlands to be as follows:

Stand density of all the species within a woodlot indicates the degree of exploitation or pressures that have taken place within the woodlands. Numerous open spaces within a woodlot displaying under-stocked or spare density, indicate that the woodland may have been improperly managed. A high density stand indicates a mature stand with possible overcrowding which in turn could affect the natural regeneration within the woodlot. It is evident from the survey that many of the woodlots display well-stocked densities with sufficient openings for regeneration to take place under normal conditions.

The degree of regeneration indicates whether or not successful regrowth is occurring to replace trees that have been extracted or that have died from various causes. The rating related to the density of young tree growth with diameters of 0.5 inches or less (DBH)* within the woodlot, and also reveals the future species that will be found in the woodlot. The majority of the woodlots studied in the Authority had fair reproduction ratings, with 25 to 50 per cent of the trees within the woodlots of 0.5 inches or less in diameter.

Most of the private forests sampled in the Authority fell within two classes, in which tree diameters (DBH) ranged from 4 to 10 inches or 10 to 18 inches. Hence some merchantable timber could be drawn from a number of woodlots on a selective type of cutting operation.

* Diameter at breast height.

The major portion of the forest cover is hardwood, although there are some stands of mixedwood, as well as some stands of white pine. These white pines are descendants of the original pine forests that were common in many parts of Southern Ontario. White pine can be found also within some of the hardwood mixtures.

3. Niagara Escarpment Woodlands

The present woodlands along the escarpment are a unique asset to the Niagara Peninsula. Consequently, the 1970 survey included cover-typing of the significant woodlots within a two-mile band along the escarpment. Woodlots were also studied for the Jordan Harbour extension in addition to the Short Hills area north of Fonthill.

The resultant cover-typing delineated the dominant species that can be found within the woodlands: namely, sugar maple, beech, basswood, ash and hickory. Furthermore, the species association revealed a definite pattern along the escarpment whereby sugar maple-basswood trees were apparent on the sloping face of the escarpment, ash-hickory, white elm and white oak were commonly found along the top of the escarpment and red oak, basswood and white ash associations were common along the base of the escarpment. Hemlock, which is shade tolerant, was common in the deeply incised valleys within the escarpment face.

Following is a list of cover types found along the escarpment:

Type Number	Cover Type	Type Number	Cover Type
4	Aspen	50	White oak
8	White pine-red oak- white ash	51	Red oak-basswood- white ash
9	White pine	52	Red oak
10	White pine-hemlock	57	Beech-sugar maple
11	Hemlock	59	Ash-hickory
12	Sugar maple-beech- yellow birch	60	Silver maple- white elm
13	Sugar maple-basswood	60a	White elm
14	Sugar maple	88	Willow

4. Private Forest Plantations

In conjunction with the 1970 woodlot surveys, private forest plantations were also studied in the Niagara Authority. These plantations were evaluated with the following aspects in mind: location and function, tree species planted, and general conditions of the plantation.

The survey indicated that the largest proportion of plantations were primarily located either on hill slopes or bottom lands; also that the plantations usually contained at least two or more tree species, although the plantations with only one species were larger in acreage. The largest plantation found was approximately sixty acres in area and it had been planted entirely with Scotch pine. The next largest plantations with one dominant species were red pine and jack pine, respectively.

The original intent of many of the established plantations is not known. However, of the plantations studied, 69 per cent provide some form of sheltering effect. These plantations, intentionally or not, provide wind protection for dwellings, roads, lanes, crops and livestock. In addition to the sheltering function, forest plantations and the resultant residual litter from the trees can provide some control measure on highly erosive soils found on steeply sloped lands. Many of the older plantations are concentrated in the northern portion of Pelham Township where much of the terrain is rather steeply sloped.

Of the plantations studied, 80 per cent had very high survival counts. The check period

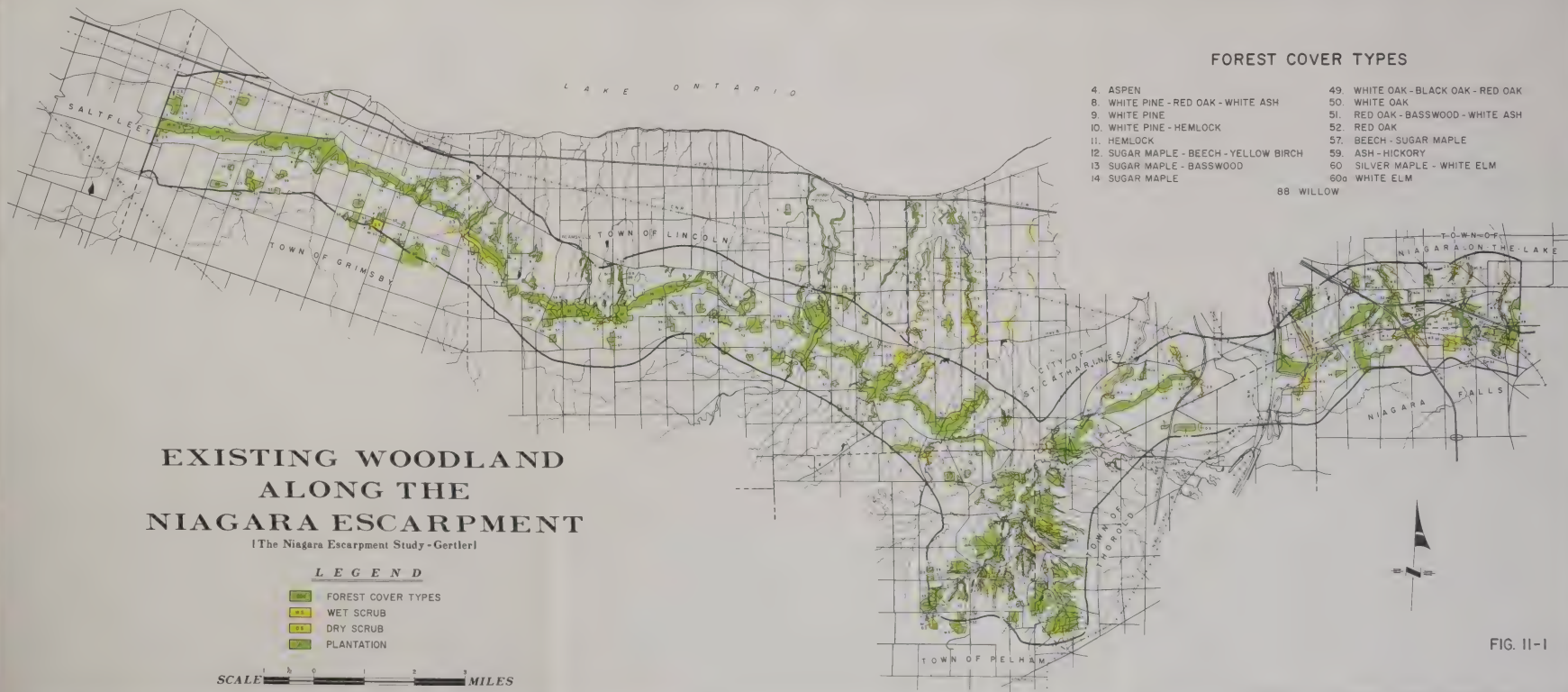


FIG. II-1

for many of the individual trees within the plantations had been short, but over-all growth was good. Stand density was also very high, with only 15 per cent of the plantations studied displaying "patchy" stands. This latter condition was more apparent in the wet low-lying areas common in Crowland and Wainfleet Townships because the excessively wet areas were not suitable for the tree species selected for the plantations.

In general, the over-all growth rate was considered to be good for 50 per cent of the plantations and varying quantities of merchantable timber were found in 12 per cent of the plantations. Those plantations displaying retarded growth rates could possibly be improved by carrying out thinning, insect control and replacement planting with suitable tree species.

Section 12

OUTDOOR RECREATION AND RELATED ACTIVITY

Recreation has played an important role in the social and economic development of the Niagara region. Historically, the Niagara Falls area has been a focus for recreational activity, attracting sightseers and tourists from all over the world.

The Niagara Peninsula is surrounded by water. Lake Ontario, the Niagara River and Lake Erie offer beaches for cottaging, boating and swimming, with Lake Erie being the most popular for this type of activity.

Inland, the Welland Canal, and of course, the Niagara Escarpment have attracted many people.

Many agencies, both public and private, have established facilities or open space for public recreation in the Niagara Peninsula Conservation Authority.

1. Niagara Parks Commission

The Niagara Parks Commission was established in 1885 to “maintain, preserve and enhance the beauty and surroundings of the Canadian Niagara Falls and the Niagara River from Fort Erie to Niagara-on-the-Lake and to develop, operate and maintain a system of recreational and educational facilities which will facilitate and add to the visitors’ enjoyment of the splendour of the Falls Area.”

Towards this end, the commission now operates a park system consisting of approximately 3,500 acres of land and encompassing such diverse features as the Falls, National Historic Sites, Hydro-electric power plants, cemeteries, golf courses, a marina, the Horticultural Gardens, significant natural areas, and various devices such as the Spanish Aero Car and boats to explore the Falls and Gorge area. In addition, the commission operates two campgrounds, Millers Creek Park, and Charles Daly Park.

The success of the operation of the Niagara Parks Commission is reflected in the visitor attendance to the area compared to Niagara Falls, New York, which is presently much less scenically and aesthetically attractive.

Projected visitor attendance to Niagara Falls, N.Y., is 7.5 million in 1975, while in 1967, Queen Victoria Park in Niagara Falls, Ontario, catered to approximately 10 million visitors.*

2. St. Lawrence Seaway Commission

This commission operates the Welland Canal, “where the ships climb over the mountain.” This is an extremely popular attraction for visitors to the area. An observation platform, visitor information centre, and picnic area are located at Lock 3 in St. Catharines.

Approximately 64,000 people excluding bus tours, passed through the turnstile to the observation platform in 1970, while it is estimated that approximately one-half million persons visited Lock 3 during the same period. +

Unfortunately, this is the only area developed for observation of the lock system although limited parking is available at all the locks. While much of the shore of the canal is developed as parkland or open space, the potential of this area has not been tapped, and is used very little by visitors or local residents.

* Niagara Parks Commission, *Long Range Comprehensive Planning Studies*, Richard Strong & Associates Limited, 1969, Page 37.

+ Personal communication with the St. Lawrence Seaway Commission.

3. Hydro-Electric Power Commission of Ontario.

This commission offers tours through its generating stations, notably the Sir Adam Beck station.

4. Ontario Department of Tourism and Information

Although not directly involved in offering recreational facilities in the area, the department plays a very important role in publicizing the region through its publications and the Visitor Information Centres, as well as the Tourist Reception Centres at the Canada-U.S. border. These facilities serve many visitors to the area, providing them with directions and information. This department is also responsible for the licensing of all tourist establishments and ensuring that these establishments conform to the standards set out in The Department of Tourism and Information Act.

5. Ontario Department of Highways

As well as being responsible for the planning, construction and maintenance of main highways, this department operates a number of roadside pullouts for picnic purposes. These areas provide at least one picnic table and a garbage can, and some also provide fireplaces. None in the area allow overnight camping. These areas are generally well maintained and provide a popular, useful recreational facility in the Authority area.

6. Municipalities

Many of the municipalities operate various types of outdoor recreational facilities including parks, playgrounds, swimming pools, cultural sites such as museums, and picnic areas.

The quality of these facilities varies greatly. However the majority, like the Wainfleet Memorial Park, are excellently maintained and offer a wide range of facilities.

7. Niagara-on-the-Lake

Mention should be made here of Niagara-on-the-Lake. This historic townsite, the first capital of the province is being preserved largely through the efforts of private, concerned citizens. The Shaw Festival, a unique theatrical production, draws many hundreds of theatre goers to the town during the summer months.

Other attractions such as the Mime Theatre, the buggy rides, pleasant parks, and a yacht harbour makes this area a prime attraction. Many agencies are also involved in the preservation of the buildings and historical artifacts of the area. The Niagara Parks Commission, and the National Historic Sites Board have been instrumental in rebuilding, publicizing and operating sites such as Fort George and Navy Hall, Butler's Burying Ground and others. Many historic plaques have been placed at homes and sites in the town. The Ontario Heritage Foundation has acquired the Niagara Apothecary and this will be operated as an apothecary museum. This area has tremendous potential as a total living museum displaying an important segment of our national and provincial heritage. Much of the potential is as yet untapped, and steps should be taken to ensure its continued existence.

8. Department of Lands and Forests

Although this department has not, as yet, developed any provincial parks in the Niagara Peninsula, it is actively engaged in a land acquisition program, with a view toward establishing a major park in the area as well as providing access to Lake Erie.

9. Private Recreational Facilities

In addition to the above government agencies offering outdoor recreation facilities, there are a number of privately owned and operated recreational facilities. These are too numerous for complete enumeration here, but most are located on Figure 12-1, "Existing Recreation



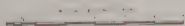
Ship-watching from the observation platform at Lock 3 of the Welland Canal.

CITY OF HAMMONTON

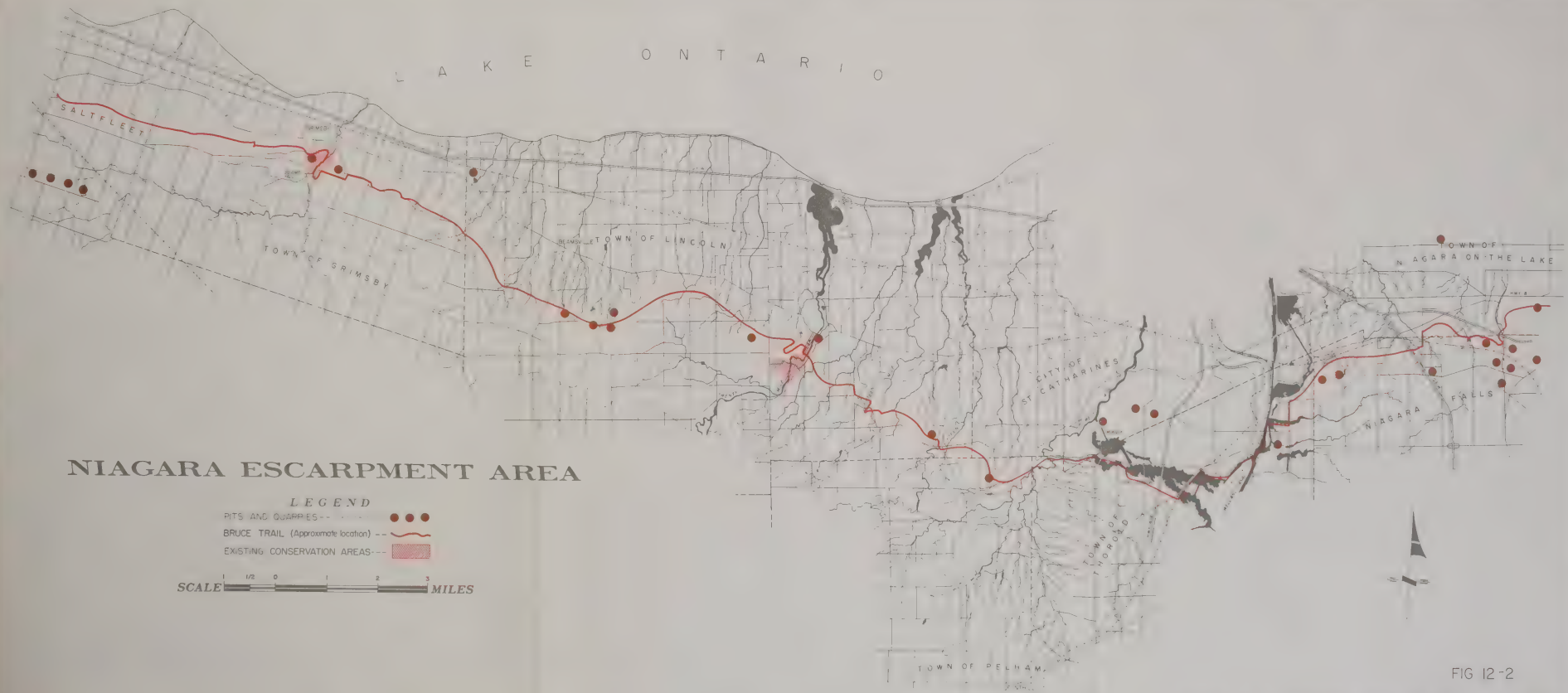
EXISTING RECREATION FACILITIES

LEGEND

- | | | |
|----------------------|-----------------|-----------|
| PRIVATE GOLF COURSES | MUNICIPAL GOLF | BOAT RAMP |
| BEACHES | MANOR | BOAT RAMP |
| PUBLIC AREAS | YOUTH CAMPS | BOAT RAMP |
| FAIRGROUNDS | RECREATION SITE | BOAT RAMP |
| AIRPORTS | | |



SHERBROOKE



NIAGARA ESCARPMENT AREA

LEGEND

- PITS AND QUARRIES -- ● ● ●
- BRUCE TRAIL (Approximate location) -- —
- EXISTING CONSERVATION AREAS -- ■

SCALE 1/2 0 1 2 3 MILES

FIG I2-2

Facilities.” Most of the privately operated camping areas are well maintained and excellently operated.

Because of the excellence of the operation, one, however, is worthy of comment here. Probably one of the best privately owned and operated camping areas in the Authority is Cave Springs Park. This excellently maintained site, covering approximately forty acres in the Town of Lincoln, offers 30 campsites and a number of picnic tables. The campsites are well spaced, and conform to the natural landscape of the area. A wading pool and pond accent the area, and there is good separation between campers and day-users. The operators are to be commended for the excellence of their operation.

Other well conceived and operated campgrounds include Shangri-La Valley, Still Acres, Bissell’s Hideaway, and Sherston Beach.

In all, 23 tent and trailer parks were inventoried during the summer of 1970. These offered a total of approximately 6,000 individual campsites, of which approximately 1,500 were serviced with electric outlets and suitable for trailers.

Within the Niagara Peninsula Conservation Authority boundaries, approximately 350 hotels, motels, and rental cabins offer sleeping accommodation for close to 29,000 tourists. Many of the cabin rental type of accommodation were inventoried, but not those in the immediate vicinity of the City of Niagara Falls where rental accommodation of various types is available.

A total of 10 marinas which cater to the boating population were located during the survey. In most cases these facilities occurred in conjunction with yacht or boating clubs, and offered approximately eight hundred moorings or dock locations, along with a wide range of services. Four of the ten had sewage pump-out facilities.

With regard to winter facilities, only one ski area at Fonthill was identified during the summer survey. This lack of winter facilities is not to be unexpected owing to the short winter season, and the relative lack of snow. Undoubtedly cross-country skiing and snowshoeing occur, especially along portions of the Bruce Trail, and snowmobiling is increasing in popularity, but, as yet no formal facilities exist for these pastimes.

10. Drives and Trails

A marked scenic drive wends its way back and forth along the escarpment from Hamilton to Niagara-on-the-Lake where it connects with the Niagara Parkway. Following back roads, this attractive drive needs some improvement, both in signing and in relocation. More will be said of this facility later in the report.

Another popular, well known recreational facility in the Authority is the Bruce Trail. This cleared, marked footpath follows the Niagara Escarpment from Queenston to Tobermory, Ontario. To date it is the longest continuous hiking trail in the province. The first section of the trail was completed (east of Beamsville) in 1962, while the whole length of the trail (approximately 465 miles) was opened in 1967. The trail is maintained by volunteers and for the most part crosses private land with the landowners’ permission.

Magnificent views of Lake Ontario and the surrounding area are available from promontories along the escarpment, while in other places the hiker can view spectacular waterfalls during the spring freshet, and many types of flora and fauna, many species of which are rare or found in few other locations in Ontario.

11. The Niagara Peninsula Conservation Authority

In operation since 1959, the Authority provides a number of Conservation Areas offering many outdoor recreation experiences to the public. These include Long Beach Conservation Area, St. Johns Conservation Area and the Virgil Ponds.

Camping, swimming and picnicking are available at Long Beach, Chippawa Creek and Ball’s Falls, while Virgil is as yet largely undeveloped. The St. Johns Conservation Area

offers a fishing pond operated on a put and take basis, as well as interpretive walking trails through one of the few fine portions of Carolinian forest still preserved. ¹

12. Cottages

Cottaging has played a significant role in recreation in the Niagara Peninsula Conservation Authority. Owing to the lower water temperatures and lack of sandy beaches there are fewer cottages on Lake Ontario than on Lake Erie. Due to the difficulty in determining whether or not cottages were being used as year-round residences, identification was almost impossible on the Lake Ontario shore. However, approximately one hundred and eighty were identified.

The best description of cottaging along the Lake Erie shore may be found in Professor J.M. Jackson's research report, *Recreational Development – the Lake Erie Shore*.^{*}

Jackson points out that the most prolific and apparent land use along the shore is the seasonal dwelling and further, the quality of these dwellings varies from virtual slum shack to opulent mansion. Approximately three thousand and five hundred cottages have been identified on the Lake Erie shore between Fort Erie and Lowbanks. American ownership accounts for more than half the ownership of these cottages, while the rest are owned by Canadians, the majority of whom live in the Hamilton or Niagara Peninsula area.

Cottages have presented special problems with respect to public access to the Lake and more will be said of this later.

13. Social and Economic Importance

Recreation can play an important role in the social as well as the economic development of a region. It is a well documented fact that owing to increasing mobility, leisure time and disposable income, greater pressure is being brought to bear upon the outdoor recreation resources of the province, and this pressure has been felt for quite sometime in the Niagara Peninsula Conservation Authority.

It is apparent that man actively seeks a periodic change in environment, and as people in Ontario become concentrated more and more in urban areas, they tend to seek natural environments in which to pursue their leisure time activities. Research has shown⁺ that continued overcrowding can lead to stressful situations, wherein social and physiological aberrations occur. This stress can be relieved by periodic release from crowded situations. Ample opportunities for high quality outdoor recreation experience help alleviate this stress thus contributing to the over-all quality of life.

It was found that the average vacation trip expenditure in Ontario in 1966-67 was \$65.^{**} It is difficult to ascertain what the future number of visits and volume of expenditures will be but in 1965, approximately three hundred and seventy thousand vacation trips to the Niagara-Iroquois Tourist Area originated from Metropolitan Toronto alone.⁺⁺

These figures and reference to the visitors to Niagara Falls and the Welland Canal demonstrate that tourism and recreation contribute a significant amount of money to the local economy. To ascertain the total economic activity generated the "multiplier effect" must be considered. The multiplier effect occurs when money spent in an area is respent to

* Jackson, John M., *Recreational Development – the Lake Erie Shore*. Research Commissioned by The Niagara Regional Development Council, Whitby, Ontario, 1967, page 134 et seq.

+ See for example, Deevey, Edward S., *The Hare and the Haruspex: A Cautionary Tale*. American Scientist V 48 Sept., 1960, pp. 415-430.

** Lusty, Gordon, *Study of Travel by Residents of Ontario*, Survey Research Limited, 1967.

++ Klopchic, Dr. P., *An Analysis of Travel Habits and Expenditures of Metro Toronto Households*, April, 1964 – April, 1965. Travel Research Branch, Dept. Tourism and Information, Toronto, 1965.

acquire further goods and services locally. It is estimated that a multiplier of "2" can be applied in Ontario.*

Thus it may be seen that recreation and tourism can play a significant role in the social and economic development of an area.

The Niagara Peninsula Conservation Authority is in a position to increase the opportunities for high quality outdoor recreation experiences in the area under its jurisdiction. Great care must be taken to ensure that recreation opportunities, be they active or passive, land intensive, like picnicking or tenting, or extensive like hiking or hunting, afford the participant an enjoyable, re-creative experience. The Authority must recognize the importance of open space acquisition now if it is to remain a positive force in the realm of outdoor recreation in the Niagara region.

* Parkway Consultants, *Niagara Escarpment Scenic Drive Feasibility Study*, 1968, page 36.

Section 13

RELATIONSHIP OF PRESENT ECONOMIC DEVELOPMENT AND WATER RESOURCES DEVELOPMENT

Early settlement in the Niagara Peninsula followed the route of the fur trading schooners along Lake Ontario and up the Niagara River. The waters of Ten Mile Creek and Twelve Mile Creek were good, and provided for the operation of mills, using water power. The development of Thorold and St. Catharines was a natural result of the location of mills at these sites. The establishment of the first Welland Canal (1829) gave rise to several new communities.

Over the years, aside from the small mills and factories, the principal water managing body has been the Welland Canal Company, regulating flows in the canals and diverting water from the Grand River at Dunnville to aid navigation. Later this function was taken over by the St. Lawrence Seaway Authority, and to some extent, the Ontario Hydro.

The constant, and abundant supply of water from the Niagara River spurred the development of facilities to generate hydro-electric power, starting in 1895. Numerous municipalities and the bulk of the region's industry relied on Niagara Falls for their power requirements, and these facilities had a significant impact on the development of the economy of the region.

The Welland Ship Canal's ponds also supplied power, and later a diversion of Lake Erie water, from the Canal to Twelve Mile Creek at De Cew Falls, gave rise to further electric power-generating capabilities.

In examining the economic evolution of the area within the Conservation Authority, one cannot separate economic achievement from the purposeful and efficient development of water resources. As the hydraulic projects became bolder and more proficient, so the region's economy became bolder and more proficient. No doubt this development of both water resources and the economy will continue in the future. However, as the demand for more water grows on the rivers and streams of the Authority, so does the burden of keeping these rivers from further deterioration. A concentrated effort on the part of all of those who are connected with water use and management, is the only avenue for solution to this problem.

PART FOUR

WATER AND RELATED LAND RESOURCE PROBLEMS

Section 14

FLOODWATER DAMAGE

The Niagara Region has a history of floods causing both damage and inconvenience, some of which date well back into the 1800s.

There can be little doubt that the flood damage is a result of man's encroaching on floodplain lands and his inability in the earlier days to foresee the possibility of higher water levels while building structures on these lands. The change in landscape from forest covered lands to intensely cultivated fields, and the subsequent urban development with more efficient drainage systems also accelerated the spring runoff resulting in increased peak flows in the rivers and streams.

Most notorious of the streams is the Welland River, whose swollen waters have inundated large areas many times both in the City of Welland and in the agricultural lands upstream. Flooding of lesser severity also plagued the areas adjacent to Twenty Mile, Beaver Dams and Forty Mile Creeks.

Almost all recorded floods were the result of a sudden spring thaw, at times combined with a heavy rainfall, as in the case of Forty Mile Creek on January 7, 1932, where, on the Niagara Escarpment, "Farms resembled lakes, ranging in depth, from a few inches to a few feet . . ." This was brought on by two days of downpour and a quick thaw.

On March 27, 1936, floodwaters of the Beaver Dams Creek cut off nearly one hundred families in Thorold, causing \$25,000 damage and drowning a great number of cattle, swine and poultry.

The Welland River rose 8 feet in 24 hours, flooding innumerable houses in the City of Welland on March 27, 1936. On February 17, 1954, the river reached the elevation of 572 feet at Beckett's Bridge, some eight miles upstream of the City of Welland causing extensive flooding.

The extent of annual "normal" floods affecting agricultural lands was found to be in the order of 250 acres for the Welland River and 220 acres for Twenty Mile Creek. These figures were based on interviews of property owners living adjacent to the two watercourses.

While the damage caused by these floods is not great, valuable agricultural land is forced out of production and, in at least two instances, several thousand dollars worth of fruit crop was lost.

Flooding within the Beaver Dams Creek watershed can be attributed in part to silting which reduced the channel conveyance downstream of the Welland Ship Canal.

While it is true that past recorded floods did not result in excessive damage, it must be remembered that, as pressures for development transform former pastures and orchards into industrial and residential areas, the threat of flood damages of great magnitudes will increase.

At the same time, the recent heavy concentration of commercial poultry farms on the flat terrain above the escarpment provide the potential for gross pollution of the nearby streams in the event of a major flood. This is especially true in the areas adjacent to the floodplain of Forty Mile Creek and Spring Creek, south of Grimsby. Further development of this nature must be properly planned to ensure that such problems will not occur in the event of a heavy runoff.

Table 14-1 gives the estimated values of peak flows for selected streams and various return frequencies. The computation of the peak flows was based on streamflow records, synthetic hydrographs and other available sources.

Table 14-1: Peak Flows of Selected Streams in the Niagara Peninsula for Various Recurrence Intervals

Stream and Point of Interest	Drainage Area Sq. Mi.	Peak Flows for the Recurrence Interval of					
		1 in 25 years		1 in 50 years		1 in 100 years	
		c.f.s.*	c.s.m.†	c.f.s.	c.s.m.	c.f.s.	c.s.m.
Forty Mile Creek, at Beamers Falls	20.65	1,500	72.6	1,750	84.7	2,100	101.7
Fifteen Mile Creek, at Rockway Falls	21.29	1,500	70.1	1,750	82.2	2,100	98.6
Forks Creek, at Welland River	55.66	1,700	30.5	2,250	40.4	2,675	48.1
Twenty Mile Creek, at Ball's Falls	113.0	4,400	38.9	5,000	44.2	5,600	49.6

Note: Flow values derived from limited data.

* c.f.s. is cubic feet per second

† c.s.m. is cubic feet per second per square mile

Section 15

EROSION DAMAGE

Soil erosion is the displacement of soil particles by water and by wind and the rate of erosion is dependent upon many factors: some natural and others due to man's activities. Physical characteristics such as soil structure and permeability are important factors when a soil is subjected to heavy water runoff or to high winds on exposed slopes. Fine-particle soils are quite susceptible to displacement when subjected to the impact of raindrops during heavy rains, especially when these soils lack adequate vegetative cover. The rate of erosion can be affected by the time and pattern of the rainfall itself in that intense rainfall over a short period on unprotected soil may cause serious soil losses. When the surface soil is soft and the sub-soil is still frozen, heavy spring rains can be particularly damaging.

Erosion can reduce agricultural crop yields. It also results in the deposition of soil material onto other lands, the filling in of reservoirs, an increase in flood potential because of more rapid water drainage through gullies, pollution of streams, silting of ditches and clogging of drainage systems.

1. Field Erosion

Areas where field erosion is either a problem at present or will obviously become a problem in the Niagara Peninsula Conservation Authority were mapped during the survey. The following are the field erosion types that were noted:

a. Sheet Erosion

Sheet erosion is initiated when runoff flows down an exposed cultivated slope, becoming a sheet of water transporting the finer topsoil particles – in effect, slope washing. This form of soil disturbance is the most subtle phase of erosion, as it often proceeds without attracting attention as no outstanding surface markings are apparent. Perhaps sheet erosion is the most serious type of erosion, since the topsoil contains most of the readily available plant nutrients and organic matter needed to support growth.

b. Rill Erosion

An accelerated movement of water on sloping cultivated fields can initiate a downward cutting action through the surface soil to form closely spaced, shallow channels called rills. The rill formations usually occur at the lower reaches of the sloping field where the runoff increases its abrasive potential.

c. Gully Erosion

Gulleys are advanced stages of rill formations, in which the depth and width of the eroded channels become rather extensive. Intense remedial work may be required to control and repair fields that have been subjected to widespread rill and gully erosion.

During field erosion investigations, it became readily apparent that the degree of erosion often related to the length and degree of the field's slope; and that the presence of soil cover in the form of stubble or other plant material can reduce the erosive power of rainfall or runoff on cultivated fields. Grain crops give the soil partial protection from erosion, while row crops give comparable protection only at their maximum development stages. Row crops provide no protection during soil preparation, planting and early growth stages.

Soil erosion is increased by poor tillage methods such as cultivating up and down slopes, lack of maintaining field edges or the encroachment of ploughing along ditch slopes, gullies or valley slopes. Lack of planning headlands upon the commencement of ploughing or the establishment of upslope dead furrows are often the initial contributors to rilling and gullying on cultivated fields.

To reduce erosion hazards, crop rotations should be considered that include sod-forming

crops, which will assist in maintaining an aggregated porous structure as compared to the restricted porosity of soil that has been continually crop-cultivated.

2. Erosion on Urban Construction Sites

During the survey, various soil erosion situations were observed within the urban settlements of the Authority. In particular the degree of soil erosion attributed to construction activity often resulted in unnecessary silt depositions. Newly exposed soil from excavations or stockpiles were often left unprotected and consequently the eroded soil particles entered natural drainage courses or municipal drainage systems in the form of silt. Hence the quality of water in natural streams is impaired, and costly maintenance work is required to clean out the municipal drains.

To control the amount of undesirable silt deposition, appropriate vegetative cover should be established on these particular sites to reduce soil erosion and silting.

3. Erosion and Logging in Woodlots

Erosion can also occur in forested areas, where different agencies cause the removal of protective litter and reduce vegetation living on the forest floor.

It became apparent that erosion of the forest floor is occurring along the steep slopes of the Niagara Escarpment, where some natural drainage courses have transcended the slope of the escarpment. It is in these locations where unconsolidated soil conditions are susceptible to erosion and consequently deep gulleys and ravines have been created within the sloping woodlots.

Potential soil erosion problems were noted in woodlots which had recently been cut-over during logging operations. In particular, the deliberate crossing of small streams by wheeled skidders and tractors for the purpose of log removal initiates unnecessary stream-bank erosion and sedimentation problems.

4. Stream-bank Erosion

Stream-bank erosion is prevalent in various forms along numerous streams in the Niagara Authority, and the locations have been mapped. Stream-bank erosion is found where the soil is exposed and subjected to the erosion activity of flowing water in a stream. A fluctuating water level in the river can often leave rather extensive areas of exposed bank for further erosion activity.

The various forms of stream-bank erosion that were documented are as follows:

a. Slumping

Slumping is the downward and outward movement of unconsolidated materials at the toe of a stream bank, usually occurs where the slope has been sharply steepened. The steep slope has little or no vegetative cover and is highly subject to the erosive action of the flowing stream current.

b. Undercutting

Undercutting usually occurs when the lower portion of the stream bank is undermined, while the upper portion of the bank is left intact to form an overhanging cliff-like situation. This form of stream-bank erosion generally occurs at the outside bank of a stream bank where the water flows fastest and hence causes greater erosive cutting action. Since a stream is a dynamic entity, and has continual changes of its course, the precise locations of slumping and undercutting can also change over a period of time.

c. Stream-bank Erosion due to Livestock

Stream-bank collapse or displacement due to the treading of domestic stock along stream banks is quite prevalent along streams in the Authority. It should be noted that not only are



Undercutting of stream banks is a common feature along watercourses in the Authority.



Livestock grazing along stream banks can often initiate soil erosion problems.



Eastport sands along segments of the Lake Erie shoreline are subject to wind action that can result in sand blow-outs.

the stream banks deteriorated, but the resulting deposition of bank material into adjacent waters can create silting and sedimentation problems.

To eliminate or reduce the incidence of stream-bank erosion, methods of bank stabilization should be considered, as well as limiting cattle access to the stream banks.

5. Wind Erosion

Wind erosion occurring on exposed, elevated surfaces can initiate soil erosion problems which are often referred to as blow-outs. In the Niagara Peninsula Conservation Authority, the exposed stone-free Eastport sands along the Lake Erie shoreline are subjected to strong onshore winds, and often blow-out situations become evident.

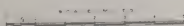
To reduce or eliminate unnecessary soil displacement along the shoreline, remedial measures such as the establishment of vegetative cover in the form of appropriate grasses, shrubs or trees should be considered. Erosion control measures have been fairly successful in the vicinity of Point Abino; however, other locations subjected to strong winds should be considered for soil stabilization measures. These latter locations are found on Lake Erie at: Windmill Point, Pleasant Beach, Reeb's Bay, Morgans Point, and west of Grabbell Point.

CITY OF HAMILTON



FIELD EROSION
AND
GRASS WATERWAYS

Legend



CITY OF HAMILTON



STREAM BANK EROSION PROBLEMS

Section 16

SEDIMENT DAMAGE

The small particles of solid matter present in water, either carried in suspension, or rolled along the streambed, which are ultimately deposited on the bottom are referred to as sediment. All streams transport some sediment, and there is no doubt that they always will.

Studies have shown that the sediment content of rivers is the highest during, or just after, the flood flows, since the capacity of water to carry sediment increases with the velocity of flow.

Fine granular soils, such as sandy loam, or silt, are easily eroded by the water moving over the ground surface and are carried into creeks and rivers. Very fine-particled cohesive materials, such as clay, are less easily eroded but the particles stay in suspension longer and travel farther downstream.

The drainage areas of Twenty Mile Creek, Forty Mile Creek, and the Welland River are located on the Haldimand Clay Plain and these waters exhibit a high load of sediment, most of which is fine clay particles. The highest recorded amount of suspended solids in this region — 190 parts per million (p.p.m.) — was measured in Oswego Creek, a tributary of the Welland River.

While there are no reservoirs on Twenty Mile Creek, the sediment is deposited in the reaches where the flow is very sluggish, encouraging vegetative growth and reducing channel capacity. Sediment is also slowly filling up Jordan Harbour.

A similar condition exists in the Welland River, where some of the sediment is trapped in the siphons under the Welland Canal. In 1969, two of the 22-foot-diameter siphon tubes were dewatered and subsequent inspection revealed that silt and debris reduced the cross-sectional area of the tubes by about fifty per cent. Further investigations by divers indicated that, while there was considerable accumulation of sediment in the conduits, the material appeared to be in a semi-suspended state, and would probably be flushed out during flood flows. The cost of silt removal and associated repairs was about sixty thousand dollars.

Table 16-1 tabulates the results of the sampling program carried out during the months of May and July in 1970. The analysis was done at the laboratory of the Ontario Water Resources Commission at Islington.

Perhaps the greatest rate of sediment deposit has been observed in Gibson Lake, the storage reservoir of the De Cew power generating station of the Ontario Hydro. The accumulation of sediment in this lake is in excess of 11 feet deep, whereas the average depth of water is less than 2.5 feet. Much of this silt is industrial waste in the form of wood fibre carried in by Beaver Dams Creek.

The quantity of silt in the easterly part of Gibson Lake was estimated to be in excess of 715,000 cubic yards. The surface area is about seventy-six acres, and the total storage is less than 170 acre-feet or about thirty-three per cent of the original capacity.

Figure 16-1 shows the accumulation of sediment in Gibson Lake through the years of 1932 to 1963, at a typical cross-section*.

The headwaters of Twelve Mile Creek originate within the gravelly kame moraines at Fonthill and contribute to the creek's sediment load. Most of this sediment ends up in Martindale Pond, located at the south shore of Lake Ontario. This pond also received the waters and silt load of the Old Welland Canal and the discharge of the Hydro's De Cew power generating station.

* From plans, aerial surveys, photographs, and from various data provided by the Ontario hydro.

The Federal Department of Public Works dredged Martindale Pond between 1965 and 1967, and 244,133 cubic yards of sediment were removed at the cost of \$266,650, with a further \$238,500 expenditure on associated works.

While these lakes are gross examples of damage caused by sedimentation, there are numerous cases throughout the Conservation Authority where silting has rendered municipal and other field drains useless, necessitating periodic remedial work.

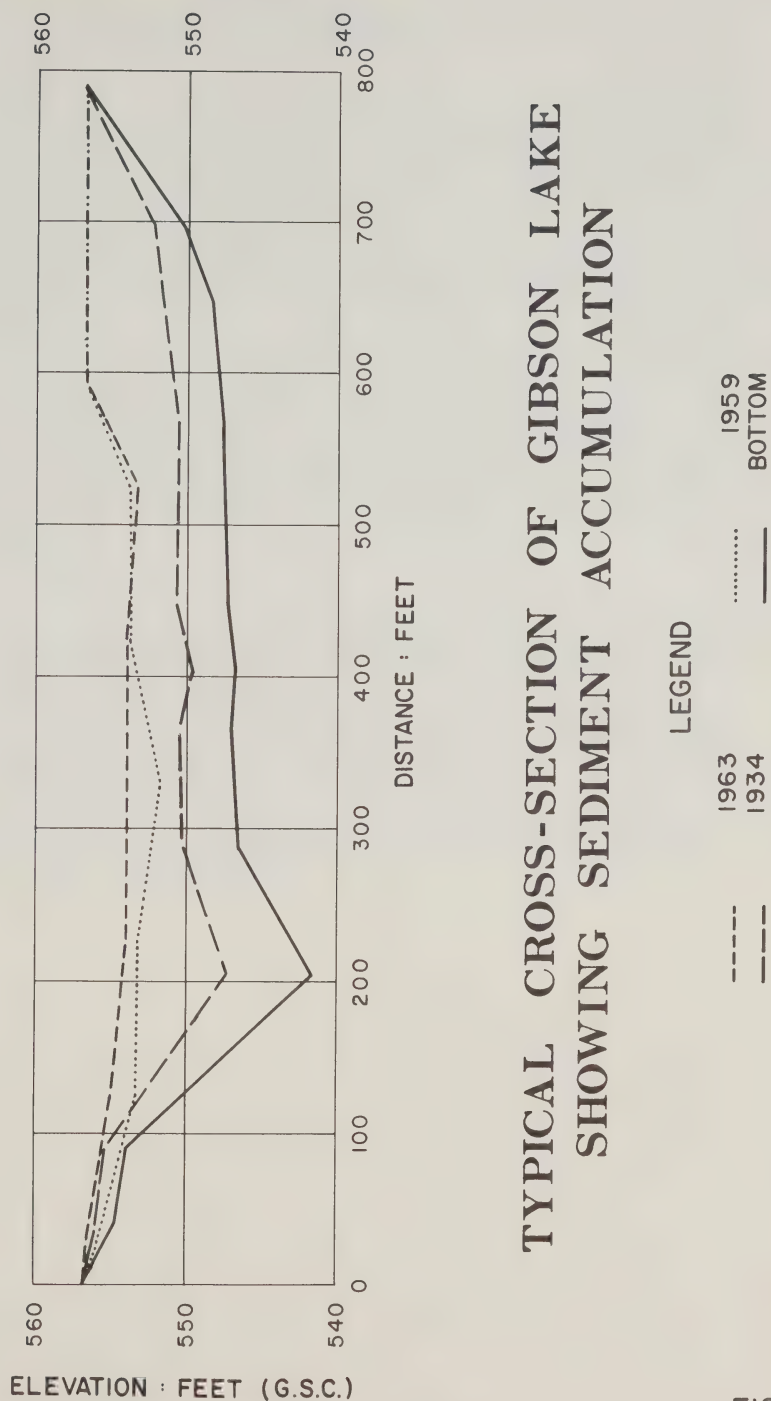
In conclusion, it may be said that the problem of sedimentation relates directly to soil erosion and industrial effluents laden with suspended solids.

Different soil types have different inherent rates of erosion which result from the presence of organic matter, colloids, and the depth of the material to a less pervious stratum. It would follow then, that in order to eliminate sediment damage, work must begin with soil erosion control.

Table 16-1: Sediment Load Present in Streams Niagara Peninsula Conservation Authority

Stream	Location of Sampling Station	No. of Station	Date of Sample	Amount of Solids p.p.m.*		
				Suspended	Dissolved	Total
Black Creek	Bridge at Con. XII & XIII, 0.9 mi. upstream from Stevensville	12A	May /70	200	610	810
		12B	July 7/70	50	540	590
Black Creek	0.1 mi. upstream from CNR crossing,	13A	May /70	340	320	660
South Tributary	1.6 mi. upstream from Stevensville	13B	July 7/70	210	610	820
Forks Creek	2.6 mi. downstream from Village of Wainfleet, 0.3 mi. upstream from CNR crossing, Con. VI, Township of Wainfleet	14A	May /70	180	400	580
		14B	July 7/70	100	400	500
Oswego Creek	Robinson Rd. crossing, Lot 6, Con. III, Township of Canborough	10A	May /70	80	560	640
Twenty Mile Creek	Con. IX, South Grimsby, 1.5 mi. south-west of Fulton	2A	May /70	5	545	550
		2B	July 7/70	10	950	960
Twenty Mile Creek	1.8 mi. downstream from Smithville	3A	May/70	20	670	690
		3B	July 7/70	10	1110	1120
Twenty Mile Creek	0.2 mi. downstream from Hwy. 8 at Ball's Falls	4A	May /70	15	525	540
		4B	July 7/70	10	590	600
Welland River	0.6 mi. downstream of Warner	6A	May /70	20	480	500
		6B	July 7/70	5	755	760

* p.p.m. Parts per million



TYPICAL CROSS-SECTION OF GIBSON LAKE
SHOWING SEDIMENT ACCUMULATION

LEGEND

- 1963
- .- 1934
- 1959
- BOTTOM

Section 17

INADEQUATE LOCAL DRAINAGE

1. Tile Drainage Systems

The advantage of tile drainage systems for agricultural purposes are well known. Improved field drainage provides the following benefits: 1) root penetration increases and hence the plant has greater access to free water during dry periods, 2) fields dry earlier and farmers are able to work the fields early in the season, 3) soils warm up sooner and 4) soil bacterial action increases to improve the fertility of the soil.

In the Niagara Peninsula, tile drainage systems have been installed in several farming areas to rectify drainage problems associated with heavier soils. In particular, some specialty cash crop farms found in Binbrook and Glanford Townships have been successfully improved by tile drainage installations.

Recent introduction of manufactured plastic tubing for drainage systems has received some acceptance by the farmers since it requires less labour and installation time is reduced.

To establish a sound tile drainage system on a farm, appropriate drainage studies and planning are involved; furthermore, the outlet of these drainage systems should be carefully considered. Improperly constructed outlet of tile systems to a stream or drainage ditch can create potential soil erosion problems. This latter point is often given little attention during the construction phase, and in some instances stream-bank deterioration as well as sedimentation problems arise.

2. Grass Waterways

A grass waterway is a drainage ditch with gradual sloping sides planted with suitable grasses for vegetative cover. In essence, the function of a grass waterway is to walk the water down sloping fields which are susceptible to erosion.

Due to the rolling topography present throughout most of the Authority, natural watercourses often transect cultivated fields. If the runoff is excessive at any one time, or the slope of field is rather steep, the cutting action of the flowing water can establish prominent gullies.

During the survey, the locations of potential grass waterway sites were mapped as were existing grass waterways that were situated in cultivated fields. Figure 15-1 indicates locations where grass waterways could be utilized.



A constructed grass waterway would reduce bank erosion and consequent sedimentation in this drainage course.



A grass waterway through this corn field would control the loss of valuable topsoil.

Section 18

WATER SHORTAGES

1. Agricultural Crops

The demand for water for crop irrigation purposes is dependent upon the local conditions and the type of crop grown. Installation costs for irrigation systems may be as high as \$150 per acre and it is obvious that only high value crops on productive sites warrant such investment.

Within the Niagara region, irrigation systems are used on market vegetables, some tree-fruits, and on small fruits. The economics of irrigating tree-fruits is open to question but irrigation of small fruits appears to be clearly profitable on many sites. On irrigated farms, the primary source of water is from lakes, rivers and creeks, although on some farms, artificial ponds are necessary to adequately supply water requirements. These ponds tend to be concentrated in the following areas: South Pelham Township, above the escarpment in Clinton Township and below the escarpment in Louth Township.

2. Livestock and Rural Domestic

Generally, adequate water is available for livestock and rural domestic purposes with the exception of the south central portion of the Authority area where a deficiency of water may occur during drought periods. When this happens, water is hauled by truck to the farms to augment existing water supplies.

Impounding of water from streams flowing through farm properties, or the provision of direct access to streams for livestock requirements, are common practices. This latter practice can contribute to stream-bank erosion and possible stream pollution and is referred to in the section on erosion.

3. Municipal and Industrial

In general, Lake Erie, Lake Ontario and the Welland Canal supply water in adequate quantity for municipal and industrial uses.

4. Recreation

Many outdoor recreation activities are dependent upon the presence of water. Water is obviously required for "primary contact" activities such as boating, water skiing, diving, and swimming. The presence of a large body of water such as Lake Ontario or Lake Erie provides cooling, onshore summer breezes, and the sound of flowing water or surf on a beach is pleasing to the senses. A view to including clean water is generally regarded as aesthetically attractive.

With exceptions in the inland areas, the lack of water presents few problems with regard to recreation. Most streams flowing over the Niagara Escarpment such as Fifteen and Sixteen Mile Creeks dry up during mid-to late summer. The primary attractiveness of spectacular "punch-bowls" and waterfalls along the escarpment is thus limited to the period during the spring freshet and shortly after.

With some rehabilitation and clearing, plus the addition of flowing water, the Old Welland Feeder Canal would provide a more aesthetically pleasing and useful recreation resource than is presently the case.

Fluctuations of the lakes, particularly Lake Erie, periodically affect recreational use of the shoreline. High water levels decrease the amount of beach area for sunbathers and increase inconveniences for cottage owners.

The problem in the area within the Authority's boundaries is not one of water quantity, but rather water quality.

Section 19

PRESENT STATE OF POLLUTION IN THE NIAGARA REGION 1969

Because of the high density of population and the great industrial complex, pollution was the most serious water problem in the Niagara region at the time of survey.

The problem arises from the components and origin of wastes. These include great quantities of pathogenic or harmful bacteria, nitrogen and phosphorus from waste treatment plants and the vast array of solids in suspension and oils and other liquids which come from the many industrial plants in the region. Some of these pass directly into the Great Lakes or the connecting Niagara River and the Welland Canal, but, as they originate in the region, they must be considered. Some of the solids fall to the bottom of the streams. In addition to the directly harmful effects of the pollutants, another serious problem is the depletion of oxygen in water, commonly measured as biochemical oxygen demand, or BOD.* This effect is discussed later.

It is natural to assume that what is visually the most obvious pollutant constitutes the most serious problem. This is often incorrect. Nitrogen, phosphorus and pathogenic bacteria in water cannot be seen by the naked eye. Bacteria can be seen through the microscope and nitrogen and phosphorus can be measured by chemical means.

There is a long history of pathogenic bacteria from the Niagara region affecting the water along the beaches, particularly of Lake Ontario, and this condition continued during the course of the survey. From the many samples taken by the Conservation Authorities Branch during the course of the survey, and examined by the Bacteriology Branch of the Ontario Water Resources Commission, the following results are typical of the conditions found.

Table 19-1: Water Quality Data

Date	Location	OWRC Lab No.	Coliform Bacteria count per 100 ml.*	Fecal Coliform count per 100 ml.	Streptococcus count per 100 ml.
June 24, 1970	Effluent from Beamsville S.T. Plant, after initial dilution (Lake Ontario)	214533	28,000,000	— Not Checked —	
July 21, 1970	Port Weller, Jones Beach (Lake Ontario)	118202	9,900	12	376
Aug. 3, 1970	Port Weller, Jones Beach (East End)	119556	54,000	2,300	—
Aug. 16, 1970	Port Weller, Jones Beach (West End)	121144	5,600	368	1,044
Aug. 3, 1970	St. Catharines Municipal Park (Lake Ontario)	119554	49,000	34,000	—
Aug. 16, 1970	St. Catharines Municipal Beach (Lake Ontario)	121142	3,000	460	648
July 1, 1970	St. Catharines Municipal Beach (Lake Ontario)	116276	4,000	56	—
July 1, 1970	Welland Canal, Port Weller	116278	6,300	24	—
July 19, 1970	Long Beach Conservation Area (Lake Erie)	118196	4,900	80	152
July 19, 1970	Long Beach Conservation Area	118195	4,900	56	96
July 1, 1970	(The above two counts were the highest counts found. All others were much lower.)				
July 1, 1970	Niagara-on-the-Lake, Middle Beach	116279	5,900	36	—
July 1, 1970	Two Mile Creek, at Virgil, downstream from septic tank	216259	71,000	—Not Checked—	
July 1, 1970	Two Mile Creek, at Virgil, downstream from septic tank outlet	216260	830,000	— Not Checked —	

* Millilitres

* The BOD is the amount of oxygen required by organic impurities to be transformed into stable compounds through the action of aerobic bacteria. This is usually measured after a period of five days incubation at 20 degrees C. The OWRC objective for surface waters is a maximum BOD of 4 parts per million.

1. Effects

a. General

The Niagara Peninsula Conservation Authority has no jurisdiction over the adjoining waters of the Great Lakes, but the Authority cannot ignore the effect which the industry and people with the area are having on these lakes. It is recognized that much of the pollution problem in these waters originates in the United States but, the contribution from the Niagara Peninsula, though *relatively* much smaller, is actually still quite large. The main concern is eutrophication, the enrichment and subsequent aging of the lake waters.

The eutrophication process is complex and is still not fully understood, but it is known that nitrogen and phosphorus and other trace elements are essential in water for the production of chlorophyll and various types of algae. Excessive growths of algae and other plants, plus a lowering of oxygen content of the water, have serious effects on other life including fish.

Nitrogen is more difficult to control than phosphorus. Quite apart from the huge quantities released from animal bodies such as man and livestock and from fertilizers, nitrogen, if in short supply, can be taken from the air directly to the water by blue-green algae. Furthermore, nitrates and ammonia (NH_4) are delivered to the water whenever there is precipitation.

Phosphorus is in an entirely different category. Soils have a remarkable facility of holding phosphorus tightly by chemical bonds. The quantities of compounds of phosphorus in precipitation are so low that they have yet to be accurately measured. In fact phosphorus enters waters chiefly from sewage treatment plants and to a lesser extent from industrial wastes and from overland flow of fertilizers from agricultural areas.

It is now generally recognized that the level of available phosphorus in water is normally the controlling factor in eutrophication. The problem of disposing of phosphorus is complicated by the fact that most treatment plants in the Niagara region receive combined wastes and storm waters and so the separate types of treatment required are not possible.

The removal of a very high proportion of the phosphorus from wastes requires special treatment, but the treatment plants in existence or under construction in the Niagara Peninsula as of January, 1971, used only primary treatment or primary and secondary treatment, i.e., removal of about 96 per cent of the solids (primary treatment) and purification of the liquid wastes by bacterial action (secondary treatment). In the average treatment plant with modern primary and secondary treatment, about 30 per cent of the nitrogen is removed and about 40 per cent of the phosphorus.*

It has been established that efficient and relatively inexpensive methods can be devised for removing 85 to 95 per cent of phosphorus in waste treatment plants. The cost should not exceed \$50 to \$60 per million gallons for operation, and the capital costs are apparently about 1 to 2 per cent of the total costs of water pollution control plants.†

The following table shows the approximate condition of the treatment plants in the Niagara Peninsula at the beginning of 1970. These are abstracted from a report prepared for the Regional Municipality of Niagara by a consulting firm with allowance for one plant which should be in full operation at the time this report is published. It will be noted that none of these plants had tertiary treatment, but it must also be noted that the Ontario Water Resources Commission has an extensive plan for the introduction, as soon as possible, of this type of treatment at least to those plants which have flows exceeding one million gallons per day, and no doubt eventually to all treatment plants.

* Owen, G.E. and Johnson, M.G., *Significance of some factors affecting yields of phosphorus from several Lake Ontario watersheds*. Publ. Great Lakes Research Division, University of Michigan 15, 1966.

† Johnson, M.G. and Owen, G.E., *The role of nutrients and their budgets in the Bay of Quinte, Lake Ontario*, OWRC report, August, 1970.

Table 19-2: Existing Water Pollution Control Plants in 1970

Location of Plant	Type of Treatment	Plant Capacity (mgd.)*	Receiving Water Body	Remarks
Grimsby WPCP	Primary and Secondary	0.75 0.45	Forty Mile Creek	To be Abandoned
West Grimsby Lagoon	2 Aeration Cells and 5.9 ac. Lagoon		Lake Ontario	
Grimsby Beach WPCP	Primary and Secondary		Lake Ontario	To be Abandoned
Beamsville WPCP	Primary and Secondary	0.2	Lake Ontario	To be Abandoned
Port Weller WPCP	Primary	8.25	Lake Ontario	Secondary Treatment under Construction
Port Dalhousie WPCP	Primary	9.0	Lake Ontario	
Town of Niagara-on-the-Lake Lagoon	32.4 ac. Lagoon		Lake Ontario	
Township of Niagara Lagoon (Garden City Raceway)	13.6 ac. Lagoon		Eight Mile Creek	
Niagara Falls WPCP	Primary	10.0	HEPC Power Canal	
Chippawa WPCP	Primary and Secondary	0.3	Welland River	To be Abandoned
Niagara Falls Lagoon			Welland River	To be Abandoned
Fort Erie WPCP	Primary	1.8	Niagara River	
Crystal Beach WPCP	Primary and Secondary	0.84	Lake Erie	
Port Colborne — East Side WPCP	Primary and Secondary	0.85	Welland Canal	
Port Colborne — West Side WPCP	Primary and Secondary	0.90	Welland Canal	
Welland WPCP	Primary	8.0	Welland River	
Smithville Lagoon	8.52 ac. Lagoon		Twenty Mile Creek	

*Million gallons per day.

b. Fish and Wildlife

The most obvious effect of pollution is the almost complete absence of useful fish in the lower stretches of the Welland River, Twelve Mile Creek and Martindale Pond. The worst pollution was noted in Martindale Pond and the Old Welland Canal. This pond at the time of survey had a bottom consisting chiefly of wood fibres and silt. The chief and almost the only major aquatic life in Martindale Pond consisted of pollution tolerant organisms, particularly members of the genus *Tubifex*, sludge worms, which are notoriously tolerant of low oxygen content in the water. *Tubifex* can live in clean water, but when it becomes the dominant genus, to the exclusion of other forms of major aquatic invertebrates, it is obvious that the water is seriously polluted.

i. Martindale Pond and Old Canal

Of 14 stations which were examined and sampled in Martindale Pond (shown on the map in the appendix) 2 showed no signs of invertebrate life. These were sampling stations 3 and 8. Station 3 was taken near an outlet pipe apparently coming from the

hospital. It is possible that the hospital may be discharging toxic effluents such as disinfectants, which may account for the absence of life at that station.

At all the other stations sampled, *Tubifex* was the dominant species found. The numbers of *Tubifex* shown in the table reached the extraordinary total of 293,760 per square yard at Sampling Area 4. This approaches the maximum number ever reported by Hynes (350,000 per square yard).* The genus *Tendipes*, probably *Tendipes tentans* a pollution tolerant midge larva, was also present at three of the stations sampled, but in relatively small numbers.

The smaller sections of the various Old Welland Canal channels are so polluted from mill effluents that they are no longer significant with regard to fish life.

So long as the present mill effluents continue to pollute Martindale Pond, no significant fish life may be expected.

Table 19-3: Chief Bottom Fauna in Martindale Pond

Date	Sampling		Numbers per square Foot of Bottom
	Area	Genus	
August 10, 1970	1	<i>Tubifex</i>	3,840
August 11, 1970	2	<i>Tubifex</i>	3,520
August 14, 1970	3	—	0
August 14, 1970	4	<i>Tubifex</i>	32,640
August 18, 1970	5	<i>Tubifex</i>	4,160
August 18, 1970	6	<i>Tubifex</i>	11,840
August 18, 1970	7	<i>Tubifex</i>	4,800
August 20, 1970	8	—	0
August 20, 1970	9	<i>Tubifex</i>	1,280
August 20, 1970	10	<i>Tubifex</i>	5,760
August 27, 1970	11	<i>Tubifex</i>	120
		<i>Tendipes</i>	40
September 1, 1970	12	<i>Tubifex</i>	192
		<i>Tendipes</i>	16
September 1, 1970	13	<i>Tubifex</i>	276
		<i>Pentaneura</i>	12
September 1, 1970	14	<i>Tubifex</i>	368
		<i>Tendipes</i>	24

ii. Welland Canal

Five dredge samples were taken just outside the mouth of the Welland Canal. The chief aquatic bottom fauna here were also members of the genus *Tubifex*. Their numbers varied from a maximum of 7,680 per square foot of bottom to a minimum of 1,600, the mean value being 3,644 per square foot. The sampling was carried out in water depths of approximately 30 feet. This water is obviously polluted.

iii. Jordan Harbour

Jordan Harbour accepts the waters of Twenty Mile Creek but also receives the effluent from a winery. The bottom of the harbour was checked with an Ekman dredge at 18 randomly selected points. The number of genus *Tubifex* found were as follows:

Maximum count per square foot of bottom	336
Minimum count per square foot of bottom	20
Mean count per square foot of bottom	99

* Hynes, H.B.N., *The Biology of Polluted Waters*, Liverpool University Press, England, 1963.



Polluted water from the Old Welland Canal and Twelve Mile Creek entering Lake Ontario at Port Dalhousie. Although 1968 conditions are shown, the situation was little changed in 1970. That year, the World Rowing Championship was held on this water.

Members of the family *Tendipedidae* were also counted and found to be as follows:

Maximum count per square foot of bottom	356
Minimum count per square foot of bottom	24
Mean count per square foot of bottom	178

Unfortunately the survey had to be made before the winery was in full operation. It can be concluded only that the waters of the harbour are probably low in oxygen and high in pollution tolerant organisms at the time when the effluent from the winery is at or near its peak and that recovery in quality is evidently slow.

iv. *The Lower Welland River*

Little time was available for checking the fish in the Welland River, east of Welland. However, as it was known from previous reports of the Department of Energy and Resources and the Ontario Water Resources Commission* that this part of the river had been seriously polluted, seine hauls were made at three points. The seine used was a 100-foot seine 6 feet deep, of quarter-inch mesh with a large bag at the centre. Approximately three thousand square feet of surface area was sampled at each haul.

Sampling Area 1 was located one-half mile upstream from the B.F. Goodrich plant. Three species of fish were caught. These included the goldfish (*Carassias auratus*), pearl dace (*Semotilus margarita*) and the gizzard shad (*Dorosoma cepedianum*).

Sampling Area 2 was located 100 yards downstream from a B.F. Goodrich plant effluent. At this point only one species of fish was found, the goldfish (*Carassias auratus*). This species is known to be relatively tolerant of pollution and low oxygen in water.

Sampling Area 3 was downstream from the Cyanamid plant. No fish were caught here.

These results may be compared with the 1954 catch of fish in Lyons Creek (a tributary of the Welland River), when 11 species of fish were caught, including yellow perch, rock bass, and white suckers. It is apparent that the lower Welland River was still not suitable for fish species of any importance in 1970.

Some streams which appear clean are highly polluted. For example, Twelve Mile Creek, near its headwaters, in Lot 5, Concession V, Pelham Township, (OWRC Lab No. 116271) showed a coliform bacteria count of 60,000 per ml. with a fecal coliform count of 350 per ml., far above the OWRC objective for maximum counts in surface waters.

Many samples were taken from the ponds in the Ball's Falls Conservation Area and the Chippawa Creek Conservation Area. In the first mentioned area the maximum coliform count per ml. was 272 and the maximum fecal coliforms 36 per ml. In the Chippawa Creek Conservation Area pond the maximum coliform bacteria count measured was 132 per ml. and the maximum fecal coliform count was 32 per ml. These areas are considered acceptable for bathing.

The best swimming in the area, as far as water quality was concerned, appeared to be in the quarry ponds west of Port Colborne. The bacterial counts from samples in this area were extremely low. The area is discussed later in this report on the subject of recreation.

* Johnson, M.G., *Biological Survey of the Welland River*, OWRC, 1964.

Section 20

RELATIONSHIP OF WATER AND OTHER LAND RESOURCES PROBLEMS TO THE IMPAIRMENT OF THE ENVIRONMENT

The foregoing sections have dealt with water pollution in the Authority area. However, the term "pollution" should bring to mind images other than polluted water, and "dirty" air. Citizens, and particularly the Authority, should be aware of other types of pollution such as soil pollution caused by poor land-use techniques or planning; pollution of landscape or "urbanscape" through ill-conceived building programs, planning and zoning; unpleasant odours; noise pollution; thermal pollution of water bodies; as well as pollution which may be defined as the degradation of visual amenities in the landscape.

All of these should be recognized in our "life space," i.e., our total environment. If this life space is allowed to deteriorate to such a point that occupation of this space is no longer a pleasant experience, then we face a serious threat to our very physical and physiological health.

Most of the "polluting" factors mentioned above are occurring at one place or another in the area and need not be elaborated upon here. It may be useful, however, to point out that one subtle but important form of environmental degradation can occur through pressures due to excessive use of recreation area.

This excessive use may lead to the lowering of the quality of a recreational experience through noise, litter, ecological damage and reduced aesthetic appeal, as well as very real hazard conditions for some activities such as swimming and boating.

As mobility, leisure time and disposable income increase, use pressures increase as well. Without care in planning, development and maintenance, pressures on available recreational resources may reach a point where the very nature of a site, often the attribute which made it attractive originally, may be destroyed.

To provide for environmental quality in outdoor recreational experiences, the planning requires:

1. That a wide range of recreational opportunities and related environments be made available;
2. that land be developed and managed to a degree of use intensity suitable to the level of quality required by the purpose for which the areas are established;
3. that no parcel of land be developed or utilized beyond a point required to maintain the quality of the environment and
4. that the entire landscape be viewed as an integral part of the recreative environment.

Well planned, high quality developments (which require careful consideration of local ecological conditions) are much more likely to generate long-term economic benefits, than are poorly conceived, hastily developed facilities designed to exploit some real or imagined short-run social or economic trend. The latter form of opportunism often does irreparable damage to the environment, and the potential of the site to provide a high quality experience may be lost.

To achieve this type of environmental quality it is essential that the Authority integrate planning with other agencies where required. The Authority has the obligation to ensure that development of its resources is controlled in such a way that environmental values are not jeopardized. With carefully integrated, systematic planning, a high quality and relatively unimpaired environment may be achieved, in which an optimum selection of recreation opportunities may be offered.

PART FIVE

PRESENT AND FUTURE NEEDS AND POTENTIAL FOR WATER AND LAND RESOURCE DEVELOPMENT

Section 21

NEEDS AND REMEDIAL MEASURES

1. Watershed Protection and Management

The planning and development of water resources, to meet the many needs of an area, is a complex undertaking. The problem involves the fact that there is an excess of water in the spring, resulting in flooding and a shortage of water in the summer resulting in drought conditions. The Authority's policy of watershed management should co-ordinate the various interests in the area, with the welfare of all the people being the dominant factor determining the best use of the water.

In order to allocate water wisely according to the various user requirements, a knowledge of the resource, both on a quantitative and qualitative basis is required. While analysis based on the watershed characteristics and precipitation data can be made to determine the behaviour of streamflows with respect to time, it is preferable to install streamflow gauges to obtain a continuous record of the flows that actually occur. Streamflow gauges should be maintained on each of the major watersheds. Existing and recommended locations for hydrologic gauges are illustrated on Figure 5-1.

2. Flood Prevention and Water Conservation

Any measure that directly or indirectly reduces damage due to floods may be considered as flood control. There are a number of proven methods of flood control and the methods applicable to the areas investigated will be discussed in this section.

a. Flood Plain Zoning and Acquisition

One of the most obvious methods of reducing flood damage is to establish flood zones in which building is restricted or controlled.

Limiting the use of flood plains by zoning requires combined municipal and Authority action. When developing zoning plans or an acquisition program, there are three important definitions to be considered (physical interpretations of these definitions are shown on Figure 21-1):

1. Design Floodway — The channel of a river or stream, and those portions of the flood plains and adjoining channels which are required to carry and discharge the flood flow of any river or stream resulting from the occurrence of a specific design storm.
2. Flood Plain Lands — The area adjoining a river or stream which has been or may be subjected to flooding.
3. Conservation Lands — In flood plain acquisition programs it is desirable to have a buffer strip between the limits of the design floodway and private lands. Where the valley is well defined, it is preferable to acquire lands to the top of the valley slopes to prevent encroachment and control erosion of the valley slopes.

In the Niagara Peninsula, the valleys of the small streams are not well defined. Therefore it is recommended that the minimum acquisition limit beyond the design floodway line be at least 50 feet.

The design storm for this region is based on a "Hurricane Hazel" type storm occurring over the particular watershed. Flood line mapping has previously been carried out on two reaches of streams within the watershed as indicated on Figure 5-1. This information is on file with the Conservation Authority.

This mapping should be reviewed and updated and further mapping undertaken in the rapidly developing areas of the region in order to prevent possible future flooding problems. As is mentioned earlier in this report, this mapping must be backed up with zoning controls or fill and construction regulations.

If the flood plain is occupied by valuable and permanent structures whose removal would be economically impractical, then flood control measures must be provided to avoid or reduce damage. These may include one or more of the following types:

b. Channel Improvements

On some streams, deepening, widening or straightening the stream channel may lessen the possibility of flooding. Benefits from this type of remedial measure are confined to the improved section and a short distance upstream. However, it is a feasible method for getting a flow of water past a potentially flood-vulnerable site.

c. Diversion

In some cases flood damages can be prevented by diverting the flood flows from their normal channel into an artificial or natural channel that removes them from the area requiring protection. In some cases it may be possible to divert the excess water to another watershed.

d. Diking

Local protection by dikes, forming artificial river banks, is possible on nearly every stream. With this method, damages are likely to be increased upstream and downstream of the protected area. This type of protection is therefore usually regarded as an expedient and care must be taken to ensure that conditions above and below the area are not aggravated.

e. Flood Proofing

Flood proofing consists of those adjustments to structures and building contents which are designed to reduce flood damages. This method is employed mostly by the individual property owners and usually only when there is not sufficient support to proceed with a project to protect the over-all area.

f. Reservoirs

Where excess flood waters can be stored in a reservoir, the benefits are more widespread than by any other method of flood control. Reservoirs may vary from small ponds to large structures and may provide any or all of the following benefits:

- Flood control
- Pollution abatement by low flow augmentation
- Water supply
- Recreation
- Enhancement of habitat for fish and wildlife.

In order for a reservoir to provide flood control benefits, the reservoir must satisfy two conditions. Firstly, the reservoir must be strategically located so that it controls a significant portion of the runoff from the drainage area above the area requiring flood protection.

Reservoirs have been built at Virgil and Binbrook and no further reservoir construction is recommended at this time.

g. Flood Warning System

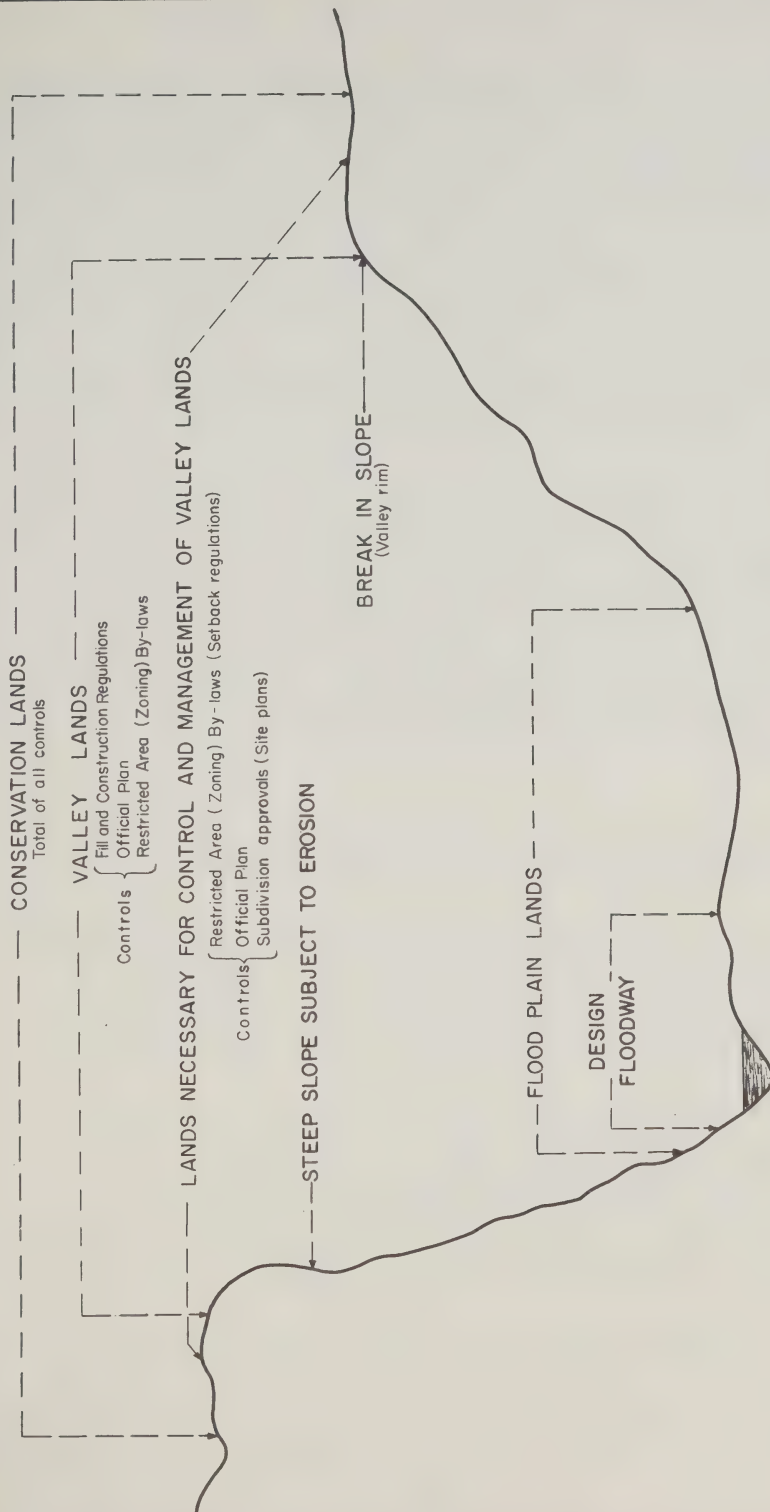
In addition to the flood control measures previously outlined, the Authority should implement a flood warning system in the Niagara Peninsula. The purpose of the warning system is to alert the citizens to impending flood conditions and to co-ordinate the operation of the various facilities to minimize flood damages.

h. Ponds

Efforts to preserve the available surface water are reflected in the number of small ponds and reservoirs existing throughout the watershed. In all, over 25 of these small reservoirs are in existence, with sizes ranging between one-third acre to seven acres.



Land fill encroaching onto the flood plain of Lyons Creek in Crowland. This practice can cause flood problems upstream and downstream and is often a source of sediment.



TYPICAL CROSS SECTION OF A RIVER VALLEY
AND POSSIBLE LAND-USE CONTROLS

Although different in size and design, their main purpose is to provide some water for irrigation, watering of livestock and recreation.

Unfortunately many of the ponds inspected in 1970 had lost a great percentage of the storage capacity, due to silting, and some failed due to lack of care in design or construction practices. Some of the small ponds also failed due to the lack of maintenance, or the deterioration of the dam embankment by the trampling of cattle.

The majority of the ponds found still in existence were dug-out, spring-fed type, less than 10 being the flow-through or bypass type ponds, having a stream as a source.

In some cases the proximity of the pond to barns and manure stockpiles caused the quality of water to deteriorate.

The Authority should encourage and promote the construction of small ponds by providing financial and technical assistance where it is applicable, or advise the concerned parties of the help available from the Ontario Department of Agriculture.

3. Municipal and Industrial Water Supply

Recommendations regarding municipal and industrial water supply were put forwarded in June, 1971, in a report entitled "The Regional Municipality of Niagara – Servicing Master Plan – Interim Report" by the firm of PARC Niagara. The proposals and recommendations contained in the report are conceptual only and were developed without the benefit of an Official Plan for the Region. In order to provide a range of alternatives based on broad water management objectives, several schemes are presented in the appendix for consideration. These alternatives, like those proposed in the PARC Niagara report, have also been developed without the benefit of an Official Plan for the region. Care should be taken to ensure that implementation of any servicing recommendation does not determine and direct development but rather that servicing should be undertaken as a result of planning programs developed in advance for the area.

4. Water Quality Control

One of the objectives of the Conservation Authority should be to see that all of those natural watercourses within its jurisdiction are cleared of pollution and that they are then kept clean.

The following measures are needed for proper water quality control:

1. It is recommended that the Conservation Authority implement a widespread and continuing program of education of the public concerning the types and effects of pollution. There is an urgent need for education of farmers concerning agricultural pollution, particularly from animal wastes, fertilizers and chemicals, and advising of the possible penalties under The Ontario Water Resources Commission Act.
Farmers should be encouraged to use alternative means of watering their livestock, and, if possible, to fence the banks of streams. This would also help to reduce stream-bank erosion and subsequent siltation of streams and reservoirs.
2. It is recommended that the Authority advise the Ontario Water Resources Commission of any specific sources of pollution which come to its attention.
3. It is recommended that the Authority bring to the attention of the Department of Health those water bodies in the area which are polluted and could be a hazard to health.
4. It is recommended that the Authority actively support the enforcement of The Ontario Water Resources Commission Act against polluters in the region.

5. Irrigation

The installation and the success of an irrigation system is dependent upon a number of

factors. Below the Niagara Escarpment, the soil type and the type of crop to be irrigated must receive considerable study since the Vineland fine sandy loam is imperfectly drained and consequently the benefits to be derived from irrigation may be limited.

Fruit-tree root systems are generally deep tap-rooted and hence many of the local orchard operators question the feasibility of irrigating the orchards situated on the sandy loams. On the other hand, small fruits such as strawberries benefit from irrigation, but the total acreage presently irrigated is rather insignificant. The total truck crop acreage irrigated within the Authority is also very small. Nursery stock producers irrigate a large proportion of their respective acreages along the Lake Ontario shoreline.

The Virgil Ponds were improved by the Niagara Authority in 1966 to provide adequate irrigation water for orchards in the surrounding vicinity. However, at the time of the 1970 survey, the number of users of water for irrigating purposes was very small. A shift in land use from orchard production and truck farming to urban development around the Virgil Pond area has altered the type of water requirement.

The continual transition of land use from agricultural production to urban development, the limited benefits obtained in irrigating some orchards and the high capital investments required to install an irrigation system are significant factors that will affect future development of irrigation in the Niagara Authority.

6. Land Stabilization and Erosion Control

In conservation planning in the Niagara Peninsula Conservation Authority, the need for land stabilization and erosion control programs will depend upon the extent and specific location of problem areas. Field surface slopes, soil texture and the type of cultivation, will influence the method of erosion control measures to be implemented.

Field cultivation up and down slopes, surface soil left exposed during winter months and the cultivation between rows on sloping orchard lands, all contribute to soil erosion. Where soils display a high susceptibility to erosion, contour ploughing should be used on suitable slopes and cover crops should be established within orchards and vineyards.

Contour ploughing is the cultivation of a field at right angles to the natural slope of the land, in order to establish a system of ridges across the slope. These ridges retard the rate of water runoff from the fields, and in so doing increase the amount of water absorbed by the soil. Limitations for contouring arise if the slopes are too steep for safe tractor operation or if the terrain is too hummocky, as the contouring curves would be excessively sharp. Where cultivated fields may be too small to implement proper contour ploughing, the possibility of fence removal should be considered to provide more extensive areas to utilize contour systems.

For situations where the slopes are far too steep for contouring methods, the maintenance of thick forage crop cover is the most appropriate method of preventing unnecessary soil erosion. A good plant population on the steep, undulating slopes will prevent the soil from becoming exposed to rainfall and water runoff.

In row crop production, the extensive tillage programs often make the soil more susceptible to sheet erosion, a problem that is especially evident in corn production.

Limited tillage programs consist of a primary fall tillage, without any spring tillage, and a once-over operation with disc harrows and possibly a finishing harrow. The time spent on row cultivation and seed-bed preparation is greatly reduced, and the soil is not overly worked. Prerequisites to implementing limited tillage are:

- the soil should be well drained
- fairly stable soil is necessary
- the soil should possess a high degree of built-in soil fertility.

The aims of erosion control are to eliminate the problem at its source by promoting



A cover crop on sloping vineyards can reduce soil erosion.



Poor slash disposal from cutting operations in this woodlot can hamper future natural regeneration.



Cattle grazing destroys useful young tree seedlings and shrubs. This practice should be stopped.



Outlet of Twenty Mile Creek at Jordan Harbour. Vegetation covers accumulated silt reducing channel capacity.



A well maintained woodlot with adequate regeneration of young tree stock.

techniques that prevent the movement of topsoil. It is recommended that the Authority consider the following actions:

1. promotion and demonstration of contour tillage planting;
2. promotion of cover-cropping between the rows in orchards and vineyards;
3. encouraging the use of crop residues either on the surface or incorporated in the topsoil;
4. promoting the minimum of tillage operations consistent with good weed control and seed-bed preparation;
5. establishing permanent vegetation in waterways in developed agricultural areas through education and an assistance program;
6. discouraging the use of riverbanks by livestock and promoting the creation and use of off-stream water holes such as by-pass or runoff ponds and
7. promoting proper logging practices in woodlots.

7. Sedimentation

Sedimentation is readily apparent in the waters of many of the streams within the Authority and can be attributed to a number of factors. The major cause is stream-bank erosion and the sediment load can vary greatly depending upon the soil types found along the watercourse. Varying quantities of streamflow and varying conditions of land cover during the different seasons of the year have considerable bearing upon the over-all sediment load.

Sediment in river water obviously impairs water quality and creates problems in utilizing these waters for various uses.

There are two different types of treatment available for achieving sediment control: land treatment measures and structural measures.

Land treatment measures have already been discussed under the previous subsection. The major structural measures commonly used include: 1) debris and sedimentation basins, 2) stream channel improvements, 3) reservoirs and 4) levees, dikes, floodways and floodwater diversions.

Of these methods, the debris and sedimentation basin is the only method that is used independently of some aspect of flood control. A debris basin is a reservoir designed specifically to trap sediment and debris. Its capacity is usually designed for the volume of sediment and debris expected to be trapped at the site during the planned useful life of the structure. Where periodic clean-out is undertaken, the design capacity can be reduced accordingly. This method can be applied effectively only where its relatively high cost can be justified.

Stream channel improvements reduce sediment load by protection of the erodable surface of the stream with the use of materials such as rock-filled gabions, concrete, or some appropriate vegetative cover. Existing reservoirs serve as sediment control devices in a similar manner to sedimentation basins. However, the sediment is not deposited uniformly or in such a way to permit easy removal.

Levees, dikes, floodways and floodwater diversions have the effect of maintaining high velocities in the stream channel and thus sediment is not deposited but is transferred to some other location downstream.

8. Associated Land Management and Adjustments

a. Urban Development

Rapid urbanization in the Niagara Peninsula is constrained by physical problems associated with three general physical categories:

- Shoreline
- River valley and watercourse areas

- Niagara Escarpment area including talus slopes, terraces and swampy areas underlain by limestone.

These areas have been delimited more specifically in other parts of this report and designated as Hazard Lands.

Appropriate control measures exist through use of local planning controls such as Restricted Area Zoning By-laws, and Conditions in Subdividers' Agreements. These can be augmented by use of the Niagara Peninsula Conservation Authority's regulatory power provided in The Conservation Authorities Act, namely, fill and construction regulations.

Specific physical problem areas will require specific remedial works depending on the extent and impacts of proposed developments. The control and financial costs can be ascertained on an individual basis also. Thus, physical improvements in proposed subdivision developments along the Great Lakes shoreline and along watercourses could be borne by the subdivider as developmental costs. These conditions may be required before final approval is given to proposed subdivision developments. It is imperative then that the Authority establish and keep close liaison with the municipalities in these matters.

It may be necessary in certain cases to develop a temporary program for controlling sediments and silt caused through rough grading and construction of subdivisions. These temporary measures will vary from site to site depending upon the physical conditions but nevertheless should be considered as a developmental cost. The Authority should be prepared to give whatever advice is required by the municipality.

b. Control of Scrublands

Scrublands are areas covered with woody shrubs and low-growing non-commercial tree species that can be found in two forms: first as dry scrub consisting usually of field invasions by hawthorn, apple, sumac and prickly ash and secondly, as wet scrub in which the typical species are dogwood, alder and low-growing varieties of willow.

In the Niagara Authority many of the abandoned pastures have reverted to scrublands, especially in the southern portion of the Authority. Once these scrub type species become established, it is rather difficult and costly to eradicate them. Where a field warrants complete clearing, the method of scrub removal can vary from clear cutting, foliar spraying or root scarification, depending on the height and degree of establishment. To reduce the possibility of dry scrub establishment, appropriate field maintenance should be carried out each season.

With respect to present conservation areas, two sites should receive some attention to remove the scrub. These are located at Stevensville and, to a minor degree, on the north fringe of the Hedley Forest.

9. Fish and Wildlife Developments

a. Fish

i. Twelve Mile Creek

It is recommended that this cold water watershed be carefully managed by private landowners.

ii. Chippawa Creek Conservation Area – Pike Spawning Area

Pike will spawn in the area during the spring flood when river levels rise. Construction of a dike and water control structure ensures that pike fry will survive in the impoundment after river levels fall, so that they may later be released into the Welland River.

iii. Wainfleet Township Quarry

The existing ponds may be developed for smallmouth bass.

b. Wildlife Areas

A number of areas in the Authority were found suitable for various aspects of a wildlife program including hunting, fishing, wildfowl propagation and nature observation. These are described in some detail in the appendix but their main features are indicated below.

i. Mud Lake Waterfowl Area

An inland waterfowl marsh which attracts a large variety of migrating waterfowl and shorebirds. The Department of Lands and Forests has demonstrated an interest in assuming the management of this area by regulating water levels.

ii. Escarpment Areas Adjoining Grimsby – Lincoln Town Line

These properties include a variety of upland habitats, a small pond and segments of the Bruce Trail. Parts of the area could be improved for wildlife by planting appropriate shrub species.

iii. Long Beach Conservation Area Lagoon System

Due to needed enlargements to the lagoon system, it is recommended that allowances be made to attract waterfowl to the area, but hunting be prohibited due to the heavy use of the area.

iv. Saltfleet Township Quarry

Waterfowl could be attracted to this area if measures were taken to raise water levels and control grazing practices.

v. Escarpment Area South-west of Grimsby

The Bruce Trail passes through this property, but regulated hunting could be initiated for upland game in sections which would create minimal disturbance to trail users.

vi. Additions to St. Johns Conservation Area

A large variety of terrestrial wildlife habitats are present on properties in this general area. Cold water streams are also present which make a trout fishery possible. An opportunity to provide hunting may exist on some properties for species such as pheasant, grouse, cottontail and squirrel.

vii. Lyons Creek Area

Excellent wood duck habitat is present on this site.

viii. Warden Woods

Additional land acquisition to enlarge the Authority Forest in the Caistor Block for wildlife management is recommended.

ix. Escarpment Area in Town of Lincoln

A section of the Bruce Trail runs through this property which exhibits a variety of upland vegetation types and portions are suitable for wildlife management.

x. Area on Fifteen and Sixteen Mile Creeks

Two blocks in particular are recommended for acquisition for wildlife purposes. Woodlots are present in both areas and populations of grouse, cottontail and deer are present.

xi. Point Abino Dune and Woodland Complex

Due to its rare floral associations, this area should be protected from development.

10. Recreational Development

The foregoing sections have outlined the potential outdoor recreation in the Niagara Peninsula Conservation Authority.

To date, however, development has occurred for the most part, in a haphazard fashion. At this time serious thought should be given to forming recreational development of this area into a systematic, over-all plan.

The following is a definition of a parks system: "Within a given land area, all parks, no matter how large they may be, or for what purpose they were established, are related to each other, to the use of resources in the landscape which includes them, and to the society which supports them. Reservation of land and water resources, particularly for parks and recreation exert as profound an influence on the use of the resources surrounding them and upon the societies which control their fate, as society and historic land-use patterns exert on the reserve; parks cannot be considered in isolation."*

A park system may be viewed in a number of ways including:

1. the total spectrum of park administration, from national to local or municipal;
2. the full range of land types included, running from the strictly resource-oriented (wilderness) to the strictly user-oriented (playground);
3. the full range of activity opportunities from entirely passive (landscape viewing) to very active (waterskiing or rock climbing).

It is obvious that no single element of the park system is entirely capable of meeting the recreation demands of all users. It is therefore desirable to provide within the system or any part of it, the greatest possible range of recreation opportunities. The Authority working in conjunction with other agencies such as the Regional Municipality of Niagara should strive to fit its recreation development to such a plan, bearing in mind the more comprehensive the plan, the greater the recreation amenities provided.

The "corridor" system has been mentioned before and is shown on Figure 21-2. Preserving open space corridors and potential recreation areas is a first step in providing this system. If possible, access to these corridors should be provided for all people in the Authority. This system should form the major "trunk" open space system. Efforts should be made to add other branches to this system and, if possible, access should be provided from the centres of the major towns and cities in the Authority.

With the increase in popularity of activities such as hiking, bicycling, and horseback riding, a series of links should be established, if possible, from every neighbourhood to the larger system, thus increasing the range of choice of areas and activities.

Specific sites such as conservation areas, scenic lookouts and private parks should form "beads on a string", all being linked by a system of scenic roads, walkways and open space.

Over-all planning will require the establishment and maintenance of close liaison with other agencies such as the Department of Lands and Forests, the Regional Government, the Niagara Parks Commission, the Department of Highways, and neighbouring Authorities to achieve a co-ordinated recreation system.

The following sites and areas were identified as the most suitable for recreation development of the type indicated. The only non-public uses in conservation areas should be concessions for specific services for public consumption, and these should be located in service zones in these areas. Ownership was not investigated in all cases, and these areas are not necessarily available to the Authority.

* Hart, William J., *A System Approach to Park Planning*. International Union for the Conservation of Nature and Natural Resources; Supplementary Paper No. 4. Morges Switzerland, 1966, page xi.

CITY OF HAMILTON



OPEN SPACE CORRIDORS
EXISTING CONSERVATION AREAS
AND RECOMMENDED
PUBLIC LAND ACQUISITION

LEGEND
EXISTING CONSERVATION AREAS
RECOMMENDED PUBLIC LAND ACQUISITION

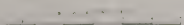


FIG 21-2

a. The Niagara Escarpment

The Niagara Escarpment is the backbone of the recreation system within the Niagara Peninsula Conservation Authority.

The Authority should proceed with a plan of escarpment land acquisition with priority given to the acquisition or control of two sites, namely:

Site I: Rockway Falls and Gorge

This area is a significant, beautiful "punch bowl" and gorge through the escarpment and lowlands. Its scenic beauty lends itself to viewing and hiking. As it is currently on the Bruce Trail, this could serve as a focal point for hikes and other trail uses.

Site II: Spring Caves

This area located on the talus slopes of the escarpment and on the old glacial Lake Iroquois plain, offers a number of amenities for recreational activities. The large blocks of limestone off the escarpment present an interesting maze of moss-covered walkways and paths. Tent and trailer camping facilities can be developed on the flatlands to the north of the escarpment.

These properties combined with Beamers Falls, Ball's Falls and any property the Authority might require east of St. Catharines would form the "beads" on the string.

The Authority should assist in the preservation of the Bruce Trail in any way possible. Some methods which should be explored are: outright acquisition of property for trail purposes, negotiation of easements for trail purposes and scenic easements. Users of the trail would also appreciate the construction of shelters in suitable locations such as existing Conservation Areas.

b. The Lakeshore Areas

The Niagara Authority is bounded on three sides by water: Lake Ontario to the north, Lake Erie to the south, and the Niagara River to the east. The shores of the Niagara River are under the jurisdiction of the Niagara Parks Commission, with which the Authority should maintain close liaison, to ensure that any Authority developments complement those of the commission.

Lakes Erie and Ontario present unique problems to any land management agency.

Lake Ontario, being much colder, attracts less recreation use than Lake Erie. Lakeshore erosion is a severe problem along the Lake Ontario shore and the lack of beaches further curtails recreation activity. Boating, both sail and power, is growing in popularity, and with this growth a distinct lack of marina facilities is evident. However, on Lake Ontario, this service is probably best left to private enterprises.

Beaches such as Lakeside Park in Port Dalhousie and Jones Beach serve the St. Catharines area residents at the present time, although water pollution does create situations when these beaches are or should be closed to public use.

The Authority should maintain close liaison with the Department of National Defence, to be notified of the disposal of Federal Department Lands, specifically those at Niagara-on-the-Lake.

Any properties acquired by the Department of Lands and Forests along Lake Erie within the Authority will add to the public recreation area.

The Authority should ensure that no public road allowances to either Lake Ontario or Lake Erie are closed or sold by member municipalities, and further, thought should be given to acquiring land away from the shore along existing open rights-of-way for purposes of parking, rest-room facilities and changerooms. A long-range acquisition plan would allow suitable individual cottage lots to be acquired as they become available.

It has been suggested that, in the south-west areas of the Authority, land should be acquired north of the lakeshore road, as erosion is rapidly making the strip south of the road too narrow for cottages.

During the survey, only one significant portion of beach which would possibly be available to the Authority was located on Lake Erie.

Site III: Sand Pit

This unused sand pit, west of Port Colborne, is on occasion used by groups, with the owner's permission and he should be approached by the Authority to open negotiations for possible acquisition.

c. *River Valleys*

Recreation potential of the inland river valleys is seriously curtailed by a number of factors. The most significant of these are low flows and pollution. Some developments such as the Binbrook Reservoir may help alleviate the low summer flow problem. However, the pollution problem is very complex and difficult to overcome. One of the main pollutants in the rivers and streams is sediment, which results in extremely turbid water making swimming and other primary contact water sports both unappealing and unsafe.

River valleys, though, can make an important contribution to the over-all system, in that they form natural corridors wherein extensive uses such as hiking and bicycling can occur. These can form the all important links in the system.

Some areas on the river system that are suitable for acquisition and development by the Authority are listed:

Site IV: Oswego Creek

A number of sites could be established along Oswego Creek providing a variety of activities. Canoeing is possible for approximately two miles up Oswego Creek from the Welland River. A small, overnight campsite and picnic area could be located west of Robinson Road, to cater to canoeists.

Farther upstream, east of Highway 3, a larger site (approximately one hundred acres) could be established as a multi-use area. This open woodland site of varied topography could offer limited camping, picnicking and an area for open space activities. The site could also be used for winter activities such as snowmobiling.

A third site, located adjacent to Seneca Line could be developed as a picnic area, with nature trails through the large woodlot on the site.

Site V: Forks Creek

This creek offers a number of opportunities for nature trail development, and provides a variety of wildlife such as muskrat, raccoon, turtles, upland and marsh birdlife for observation. A focal point for a trail system could be located on Forks Creek at the location shown. This site would be suitable only for picnicking and rest-room facilities for hikers.

The Welland River has a comparatively high potential for boating. The Authority has already recognized this potential by establishing a boat launching ramp, camping and picnic facilities at the Chippawa Creek Conservation Area. Further launch sites and picnic areas should be developed along the river to cater to the boating population.

Site VI: Jordan Harbour

To further provide for the boating population a small boat-in picnic facility could be established on the east bank of the south end of Jordan Harbour (Site VI). Ideally the Authority could acquire all the escarpment lands along Twenty Mile Creek between the Ball's Falls Conservation Area and Jordan Harbour.

Site VII: Feeder Canal

If deemed feasible this abandoned canal should be rehabilitated as far as possible. It would provide an excellent facility for hiking, canoeing and nature observation.

Sites VIII to X: The Old Welland Canals

The historical significance of the Welland Canal is dealt with elsewhere in this report. It is sufficient to note here that the canal has played a key role in the development of the province and the country.

The recreational assets of the canal have not been developed by the St. Lawrence Seaway Commission. The Authority should enter negotiations with the commission as soon as possible with a view to administering some of the canal lands for recreation purposes.

The canal is currently in the fifth stage of development. The original canal, for the most part is gone. Portions of the second and third canal still exist, but are rapidly being filled in or torn down. The Authority should attempt to acquire representative locks of all stages and develop them as interpretive sites, depicting the history, location and points of interest of the canal system. Sites VIII to X are suggested for attention.

Site XI: The Welland Canal

A portion of the present canal is to be abandoned shortly. This section, through the City of Welland offers a number of sites showing high potential for recreation use. If water can be held in the abandoned sections, the Authority should investigate the possibility of developing numerous sites, offering facilities for picnicking, boat launching, hiking and nature study, and mini-biking in restricted areas.

Site XII: The Welland Diversion

The Authority should work closely with the St. Lawrence Seaway Commission with a view to developing the land adjacent to the fifth stage of development, the Welland Diversion, for recreational purposes. This land has been architecturally designed as a ready-made, contoured park site, and could be developed for intensive day use purposes.

The Authority should also use its influence to include parts of the canal, especially the observation towers at Lock 3, on the proposed Scenic Drive.

e. *Other Areas*

Site XIII: Quarry – Port Colborne

This quarry, about to be abandoned by the Canada Cement Company, should be acquired by the Authority for recreational purposes. It is currently heavily used by local people, especially for swimming, and this uncontrolled use is having a severe detrimental effect on the site, due to litter, broken glass and uncontrolled vehicle activity.

This multi-use site offers a number of recreational opportunities.

The quality of the water in the abandoned quarry is exceptionally good, and with improved access in the form of a beach would provide an excellent swimming site. Picnicking and limited trailer camping could also occur on the site.

One area of the site is rich in Devonian and Silurian fossils and would appeal to “rock hounds”.

The Authority should consider the acquisition of other abandoned pits and quarries in the area. These would provide excellent sites for shooting ranges.

f. *Trails and Routes*

The Bruce Trail traverses the length of the Authority and is an asset to the region. Where possible the Authority should assist the Trail Association. Consideration should be given to the establishment of a trail along the Welland Canal which would tie in with the Bruce Trail.

With regard to scenic drives for automobiles, the Authority should make valid inputs to and support the Tri-County Scenic Drive Committee. A consultant's report is available on the proposed Scenic Drives. Owing to the rapid decline in the number of acres of tender fruit lands due to expanding urbanization, the Authority should consider acquisition of a number of representative orchards along the scenic drive. These could be acquired on a lease-back basis, thus saving the Authority the expense of actual operation. An important attraction of the Scenic Drive is the spring blossoms and, unless steps are taken soon to preserve some orchards, this attraction may be lost.

Rockway Falls and gorge are scenic areas that offer fine hiking and viewing.



One of the large ponds at the Port Colborne quarry. Better access, such as a beach, would improve this excellent swimming site.

Section 22

LAND RESOURCE AVAILABILITY

Prior to implementation of any remedial measures, the Authority should consider the varied interests of resident and non-resident land owners, in addition to the physical characteristics and capabilities of the landscape of the region.

The Niagara Peninsula Conservation Authority must adopt policies to minimize the loss of natural land resources and the destruction of the general configuration of the environment and its amenities. This will involve public participation and inter-agency co-operation in policy development and implementation.

The availability of land for Authority projects will be influenced to a great degree by the following conditions:

1. Land Speculation
 - a. A demand exists for land for farm and non-farm rural holdings as well as for private recreation areas. This demand is apparent along the Niagara Escarpment and the lake shoreline.
 - b. Lands located in close proximity to urban centres are subject to speculative pressures related to urbanization.
2. External influences affecting the agriculture sector which make the future of conversion of rural lands unclear.
 - a. Shortage of farm labour and other employment opportunities.
 - b. Uncertain markets.
 - c. Improvement of marginal lands.
 - d. Leasing of lands to increase effective farm holdings.
 - e. Changing emphasis in farming operations.
3. Municipal land-use controls and development policies.
 - a. The Regional Municipality of Niagara is preparing an Official Plan. This Plan may:
 - i. require lakeshore erosion controls as prerequisites for development,
 - ii. require public access to shorelines and valley lands,
 - iii. limit or encourage non-farm use in rural areas.
4. Other public agencies' policies and programs.
 - a. Provincial departments, agencies and commissions.
 - b. Federal departments and commissions.

PART SIX

The most important recommendation of this report is the formulation of a comprehensive plan of action by the Conservation Authority. Work on such a plan should be started at once. Within one year, the plan should be drafted, discussed, revised where necessary and finally adopted as a statement of Authority policy.

The following sections are intended to assist in the preparation of the Conservation Plan and the staff of the Conservation Authorities Branch is available for discussion at each stage of the planning process.

CONSERVATION PLAN

Section 23

PURPOSE OF THE PLAN

In order to solve as many as possible of the problems presented and implement the recommendations of this report without delay, but within the financial competence of the participating municipalities, it is necessary to adopt a Conservation Plan. This plan is intended to achieve a number of objectives.

1. To define Authority policy so as to serve as a guide to the Authority in exercising its powers under The Conservation Authorities Act.
2. To provide for the orderly implementation of measures to ensure the maximum benefit to society of the land, forest, water, wildlife and recreational assets of the Niagara Peninsula.
3. To provide a basic framework within which more detailed conservation planning can take place.
4. To ensure stable budgeting by the Authority and the participating municipalities.
5. To provide policy guidelines and direction input into other planning processes initiated by member municipalities and/or other public agencies.
6. To assist in the integration of Authority action with that of other agencies to achieve the most effective and economical total conservation program for the Niagara Peninsula.

Section 24

BASIS OF PLAN

The Conservation Plan will be based on the studies and analyses carried out by the Conservation Authorities Branch of the Department of the Environment. Details of the studies are contained in Volumes I and II of the Niagara Peninsula Conservation Report. Some of the more important considerations are as follows:

1. The Niagara Peninsula is an area composed of municipalities with separate jurisdictions, yet to some degree dependent on one another, and all closely associated with the natural resources of the watershed.
2. Urban development and specialized agriculture will continue in the corridor between the Niagara Escarpment and Lake Ontario. Existing urban centres will continue to grow depending on development policies established by the Regional Municipality. Permanent non-farm development will continue to expand in the agricultural areas but will be influenced by policies developed by the Regional Municipality. The westerly segment of the Authority will continue in agriculture but at a more intensive scale.
3. Demands for recreation opportunities will be most concentrated along Lake Erie, Lake Ontario and the escarpment. The escarpment is of primary interest for public open space recreation lands. Although recreational opportunities along both Lake Ontario and Lake Erie shorelines are pre-empted by cottages and homes, it is important that additional shoreline lands be acquired, despite their anticipated high costs.
4. The Authority's resource management objectives can be carried out successfully only if member municipalities co-operate by adopting land-use regulations such as subdivision policies, zoning by-laws and Official Plans which are consistent with Authority policies.
5. The activities of the Authority will be closely co-ordinated with those of other resource agencies of the local, regional, federal and provincial governments.
6. The multi-use principle will apply in the development of Authority projects and programs.
7. The Authority will organize its activities so that the general public will be encouraged to participate actively.
8. The Authority will receive local municipal financial support sufficient to carry out an adequate conservation program.

Section 25

DEVELOPMENT POLICY

In order to crystallize its thinking for the benefit of the Authority members and the participating municipalities, the Authority should formulate a clear statement of development policies. The statement below might be considered by the Authority as an example of the form which such a policy statement might take:

1. General Policies

The general policies governing all developments of the Niagara Peninsula Conservation Authority are as follows:

- a. Management of all existing natural resources must be compatible with the needs and demands of the population and the growth and development of the municipalities.
- b. The Authority will co-ordinate its activities with other agencies concerned with resources, such as the Departments of Lands and Forests, Agriculture and Food, Municipal Affairs, and Transportation and Communications; and the District Health Units, Ontario Water Resources Commission, St. Lawrence Seaway Authority, Niagara Parks Commission and the Ontario Hydro.
- c. The Authority will encourage municipalities and planning boards to adopt land-use regulations, and will endeavour to have incorporated within these regulations policies which are consistent with the resource management objectives of the Authority.
- d. The Authority will prepare and register fill and construction regulations under the provisions of Section 27 of The Conservation Authorities Act, and co-ordinate these with Official Plans and zoning by-laws. Top priority will be given to urban or urbanizing areas and Niagara Escarpment areas.
- e. The principle of multiple land use will be recognized and particularly in areas of higher population densities.
- f. The preservation of the natural environment including areas of natural, scenic, biological and historic interest will be included in the Authority's program of resource management.
- g. In co-operation with other interested agencies, the Authority will endeavour to ensure adequate stream flows and the improvement of the quantity and quality of surface water supplies.
- h. The financial levy in any year to a member municipality shall not exceed 0.5 mills on the provincial equalized assessment, except where the municipalities concerned request a special project and are prepared to assume the Authority's share of the cost.
- i. Initially, the Authority will emphasize the acquisition of lands required for its various projects.
- j. The Authority will establish advisory boards in order to enlist the skills and interests of qualified citizens as well as those of Authority members.
- k. The Authority will establish an active educational program in order to communicate to all residents, of all ages, in the watershed, an understanding of the Authority's aims, objectives, and technical and financial assistance programs. This will involve meetings, publications and displays showing the technical, financial and integrative roles of the Authority in maintaining and enhancing those amenities which sustain a pleasant environment within which to live, work and play.

2. Water Development Policies

In the development of water management projects the Niagara Peninsula Conservation Authority will adhere to the following specific policies:

a. *Streamflow and Water Conservation*

- i. Adequate streamflow will be maintained where possible by the use of dams and diversions to enhance and preserve the quality and usefulness of the streams.
- ii. The Authority will encourage and promote the construction of small ponds throughout the watershed to provide water for irrigation, watering of livestock, recreation and low-flow augmentation.

b. *Channel Improvements*

- i. Flood-vulnerable sections of urban areas will be protected by the construction of channel improvements where other methods of flood protection are not feasible.
- ii. Channel improvements will be designed to discharge high flows and withstand high velocities without creating adverse downstream effects.
- iii. Lands necessary for the construction of channel improvements will be acquired or otherwise controlled to prohibit additional developments which would interfere with the eventual proper development of the projects.

c. *Sediment Control*

- i. The Authority will undertake a program to promote proper land-use practices to reduce siltation of the stream channels and improve streamflows.
- ii. The Authority will promote the installation of sediment and debris basins to protect hydraulic installations where feasible.
- iii. The Authority will undertake a continuing program of measuring the silt accumulation in reservoirs.

d. *Land-Use Regulations*

- i. Action will be taken to restrict the use of flood-prone areas, valley slopes, shorelines and hazard lands to such non-intensive uses as agriculture, parks and recreation through regulations pursuant to Section 27 of The Conservation Authorities Act, and through co-operation with municipalities in zoning development control.
- ii. A systematic program of flood plain and stream valley land-mapping will be initiated to provide information to municipalities and private owners on flood and erosion-vulnerable lands.

e. *Water Quality*

A program of periodic water sampling above, at and below communities and industries will be established to assist the Ontario Water Resources Commission in locating and controlling sources of water pollution.

3. Fish and Wildlife Development Policies

The Niagara Peninsula Conservation Authority is interested in establishment and maintenance of optimum fish and wildlife and plant communities and will, therefore, pursue the following policies:

- a. Frequent liaison will be maintained with the Aylmer District Offices of the Department of Lands and Forests.
- b. Land will be acquired for a combination of wildlife and forest purposes.
- c. Authority-owned land will, wherever feasible, be open to hunting during the open seasons.
- d. Landowners will be advised and/or assisted in such improvements as the installation of Wood Duck nesting boxes and construction of small dams to improve wildfowl habitat.
- e. Action will be taken to acquire, wherever possible, areas of special interest having rare species of fauna or flora.

- f. In co-operation with the Department of Lands and Forests an effort will be made to improve “sportsmen-landowner” relationships.
- g. Private landowners will be encouraged to reduce the posting of lands and particularly of fishing waters, substituting if possible the issuing of permits to fish or hunt at a daily fee.

4. Recreational Development Policies

The Authority will embark on a phased program of establishing a network of trails, routes and conservation areas as shown on Figure 21-2, and in doing so will adhere to the following policies:

- a. All developments will be of a high quality, and will be developed with the assistance of professionals, such as landscape architects.
- b. A Conservation Area Classification and Zoning System will be adopted and applied in the development of all Authority lands.
- c. Liaison will be established and maintained with public agencies such as the Department of Lands and Forests, Department of Transportation and Communications and adjoining Authorities, to ensure a regionally co-ordinated development of recreational resources and facilities.
- d. Member municipalities will be encouraged to incorporate within Official Plans, such provisions as will enhance the natural beauty and environment of the watershed.

5. Land Use and Forestry Development Policies

The Authority, with the assistance of the District Offices of the Department of Lands and Forests and the Department of Agriculture and Food, will pursue the following policies to ensure the wise use of land and forest resources:

- a. A phased program of acquisition of woodlands will be established with the aim of acquiring not less than 200 acres per year.
- b. Purchases will be such that consolidated blocks of property are eventually created.
- c. Lands having small ponds, stream shorelines and wetlands as major features will be developed for combined forestry, wildlife and other compatible uses.
- d. Private land advisory and assistance programs will be set up to promote:
 - i. better drainage systems;
 - ii. erosion controls through proper cultivation practices, and the establishment of grassed waterways;
 - iii. stream-bank stabilization and improvement through the establishment of vegetative cover and protection from livestock;
 - iv. the creation of windbreaks and shelterbelts;
 - v. the reforestation of submarginal areas on private lands.

Section 26

DEVELOPMENT PRIORITIES

Priorities will be established after due consideration of the background studies carried out by the Conservation Authorities Branch, the development policies of Section 25 and the financial capabilities of the Authority. The priorities cover a five-year period, but the projects have been selected within a broader, long-range program. The priorities will be adjusted from time to time as conditions warrant, and a complete review will be carried out after the first five years.

The priorities must be read in conjunction with the following maps:

Figure 5-1 Surface Water Resources

Figure 15-1 Field Erosion and Grass Waterways

Figure 15-2 Stream-bank Erosion Problems

Figure 21-1 Typical Cross-Section of a River Valley and Possible Land-Use Controls

Figure 21-2 Open Space Corridors and Potential Conservation Areas.

1. General Programs

There are a number of recommendations within this report, which do not involve major expenditures, but which are, nevertheless, of major importance to the over-all resource management objectives of the Niagara Peninsula Conservation Authority.

Therefore, the Authority will take steps to have the following programs implemented immediately.

- a. The establishment of advisory boards to propose and expedite the consideration of Authority programs. This will include an Environmental Management Advisory Board which will assess and advise upon the over-all effect upon the environment of all proposed developments, including Authority projects, in the watershed.
- b. The notification to the Ontario Water Resources Commission and other appropriate authorities of the urgent need to remove pollution from the following sources:
 - i. municipal sewage treatment facilities at Grimsby;
 - ii. various sources at Vineland, Jordan, Virgil, St. Davids, Stevensville; and the shores of Lake Erie from Port Colborne to Fort Erie;
 - iii. inadequate sewage lagoons at Smithville;
 - iv. industrial wastes from:
 1. Ontario Paper Co. Ltd., Thorold
 2. Abitibi Provincial Paper Ltd., Thorold
 3. Domtar Construction Materials Ltd., Thorold
 4. The Beaver Wood Fibre Co. Ltd., Thorold
 5. Hayes-Dana Ltd., Drive-Drain Division, Thorold
 6. Garden City Paper Mills Co. Ltd., St. Catharines
 7. Domtar Fine Papers Ltd., St. Catharines
 8. Barnes Wines Ltd., St. Catharines
 9. Canadian Cannery Ltd., St. Catharines
 10. Grantham Packers Ltd., St. Catharines
 11. Tregunno Niagara Farms Ltd., Pelham
 12. Cyanamid of Canada Ltd., (Welland Plant), Niagara Falls
 13. B.F. Goodrich Canada Ltd., Niagara Falls
 14. Ford Motor Co. of Canada Ltd., Niagara Falls
 15. Norton Company, Niagara Falls
 16. Atlas Steels Ltd., Welland
 17. Welland Tubes Works, Welland
 18. The Steel Co. of Canada Ltd., Welland

19. Gould National Batteries of Canada Ltd., Fort Erie
20. Robin Hood Flour Mills Ltd., Port Colborne
21. The International Nickel Co. of Canada Ltd., Port Colborne
22. Arkell Tools Ltd., Grimsby
23. Culver House Canning Ltd., Lincoln;
- v. animal waste disposal at poultry, swine and cattle producers.
- c. In co-operation with the Department of Lands and Forests, the establishment of:
 - i. liaison among agencies, and private landowners to secure agreements for fishing, hunting, motor tobogganing and hiking trails on private land.
 - ii. 4-H Forestry Clubs which will instill in young people an appreciation of special character of the Carolinian forest which is found in such a limited part of the province.
- d. The adoption of a Conservation Areas Classification and Zoning Scheme as a tool for the planning, development and management of all conservation areas.
- e. The establishment of a working liaison with member municipalities, to review the adequacy of present land-use planning regulations as they may affect conservation policies and objectives; and the provision of assistance in formulating policies and land-use regulations consistent with Authority policy, particularly in flood-prone areas, areas of unusual natural beauty and lakeshores.
- f. The establishment of an active educational program in order to communicate to all residents of all ages in the watershed an understanding of the Authority's aims, objectives and technical assistance programs.

2. Detailed Programs

The detailed projects and programs of the Authority for the first five-year period are set out below. They are classified as either Continuing or Specific, depending on the length of time required for completion. The notation in brackets refers to the dominant purpose of the program.

Continuing Programs

- | | | |
|----------------------|----|---|
| (Water) | 1. | The maintenance of a network of stream and precipitation gauging including the recruitment of gauge readers, investigation of sites and establishment of stations. |
| (Water, Land) | 2. | The establishment of a continuing program of flood plain and valley land mapping, resulting in fill and construction regulations covering these areas under the provisions of Section 27 of The Conservation Authorities Act. |
| (Water) | 3. | The establishment of water sampling program in conjunction with the Ontario Water Resources Commission, concentrating on areas of permanent residential or industrial development. |
| (Wildlife) | 4. | The establishment of a program to advise private landowners on the construction of small dams to improve wildfowl habitat. |
| (Forestry, Wildlife) | 5. | The initiation of a continuing program of acquisition of lands suitable for management as combined Forestry, Wildlife and Recreation areas: Table 26-1 gives the priorities and a brief description of lands suitable for these purposes. Approximate locations are shown on Figure 21-2. |
| (Recreation) | 6. | The promotion of an expanding network of hiking trails, and in particular the Bruce Trail, through public ownership or agreement with private landowners as combined-use corridors and the publishing of guide books. |

- (Recreation) 7. Continued liaison with the Tri-County Scenic Drive Committee to ensure the laying-out of scenic drives and scenic “circle” routes with roadside facilities and compiling of information for eventual publication of a route guide book.
- (Land) 8. The establishment of a program of grassed waterways construction, pasture land improvement, improvement of field cultivation methods, using a combination of the following methods:
 - i. demonstration projects established and maintained by the Authority in several areas;
 - ii. provision of technical and financial assistance to private landowners.
- (Land) 9. Initiation of a program of technical and financial assistance to private owners of erosion-prone lands along the banks of creeks in order to prevent further deterioration of the banks.

Specific Programs

Certain specific projects will be carried out in an order to be listed, as in the examples below:

- (Water) 1. Study of the feasibility of the following alternative servicing plans.
 - a. Pipeline for the Town of Niagara-on-the-Lake
 - b. Pipeline for Vineland-Jordan
 - c. Rehabilitation of disused feeder canal.
- (Wildlife) 2. Construction and operation in conjunction with the Department of Lands and Forests, of the pike spawning structure at Chippawa Creek Conservation Area.
- 3. Participation with private landowners in the establishment of demonstration grass waterways on chosen sites to control erosion, e.g.,
 - a. stream course in North-half lots 15, 16, 17, Concession 1, Caistor Township
 - b. stream course east from regional road 50 in Block 127, Thorold Township.

Table 26-1: Purchase Priorities for Combined Forest, Wildlife Management and Recreational Areas

Priority Group	Name	Location	Approximate Acreage
I	Rockway	Lots 7, 8, Concessions VI and VII Lots 9, 10 Conc. VIII, Louth Twp.	400
I	Spring Caves	Lots 11 & 12, Concessions V & VI Clinton Twp.	300
I	St. Johns	Bks. 155, 156, 161, 162, Thorold Twp.	200
I	Beamers Falls	Lots 8 to 15, Concession II, N. Grimsby Twp.	600
II	Point Abino	Lots 32 & 33, B.F. Con. Bertie Twp.	200
II	Sixteen Mile Creek	Lots 12, 13, Concession V Lots 13 & 14, Concession VI Lots 15 & 16, Concession VII	260
II	Indian Line	Lots 10 to 19, Concession I Caistor & Canborough Twps.	1,400
II	Port Colborne Quarry	Lot 3, Concession I, Wainfleet Twp.	200
III	Lake Erie Sand Pit		10
III	Welland Canal Properties		500
III	Oswego Creek		100
III	Forks Creek		100
III	Jordan Harbour		20
III	Feeder Canal		100

Section 27

IMPLEMENTATION

This plan will be implemented by the Niagara Peninsula Conservation Authority in conjunction with the member municipalities and private or government agencies whose activities will have an effect on conservation measures.

Specifically this Conservation Plan will be implemented by the following:

1. successive five-year budgetary programs reflecting the current grant structures, the financial capabilities of the member municipalities and the Development Priorities outlined in Section 26;
2. the integration, wherever possible, of the policies and programs of this Plan with existing and future municipal and regional Official Plans, restricted area (zoning) by-laws and development programs;
3. co-operative action with public or government agencies and departments;
4. a program of public relations and conservation education and
5. Project Plans conforming to this Plan, but outlining in detail specific projects to be undertaken by the Authority and co-operating agencies.

Department of the Environment

— HON. GEORGE A. KERR Q.C., Minister — — J. C. THATCHER, Deputy Minister —

— N. D. PATRICK, Director, Conservation Authorities Branch —

— **niagara** —

— **peninsula** —

— **conservation** —

— **report** —

1972

— **volume II** —



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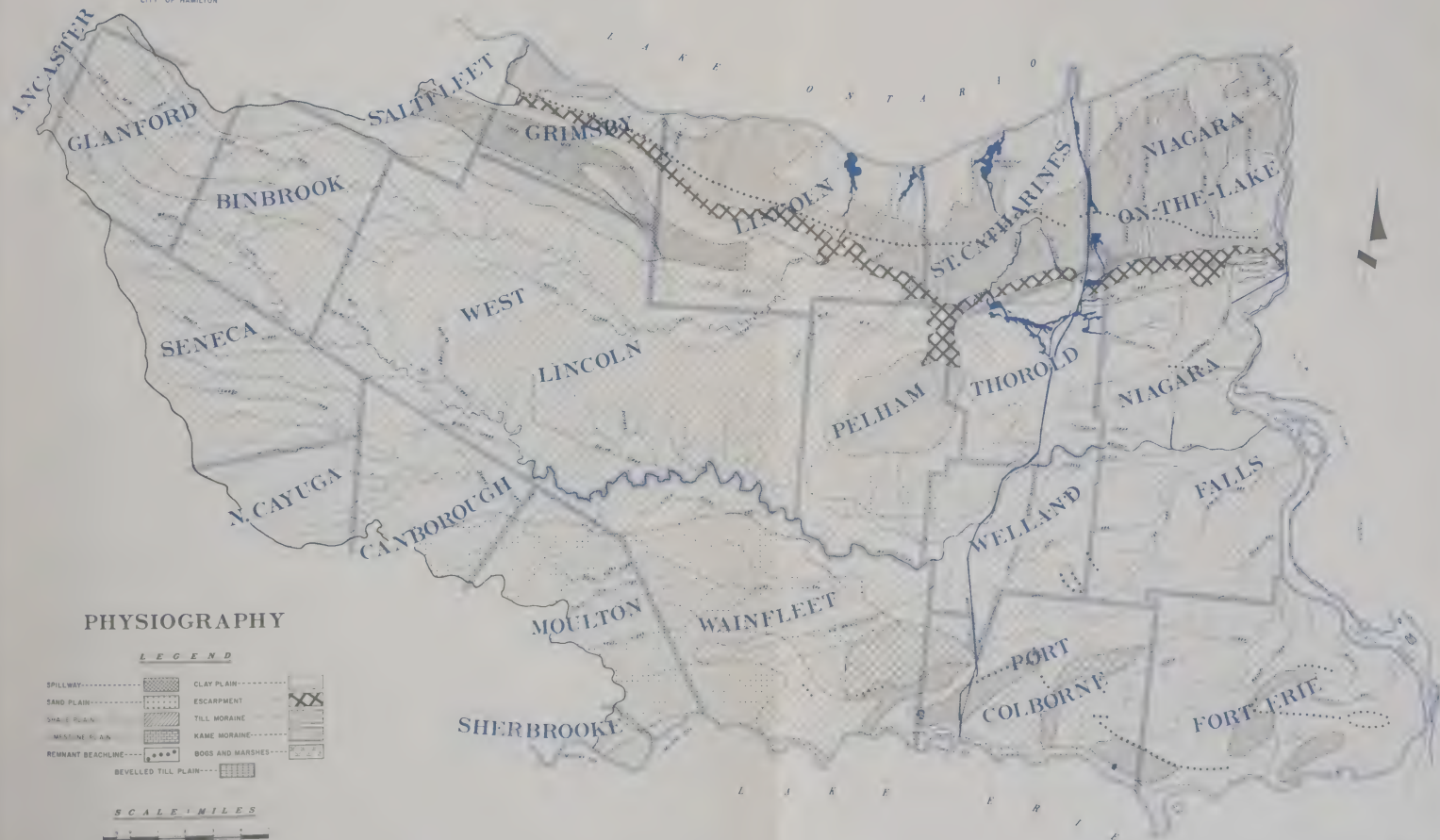
INTRODUCTION

This volume is an appendix to Volume I, Conservation Report and Plan. It contains additional maps, tables and sections of text, valuable to Authority members or others responsible for implementing the Plan, but more technical or detailed than required by the broader readership of Volume I. No attempt is made to provide a connected narrative. Volume II is printed in limited quantity for distribution to those concerned.

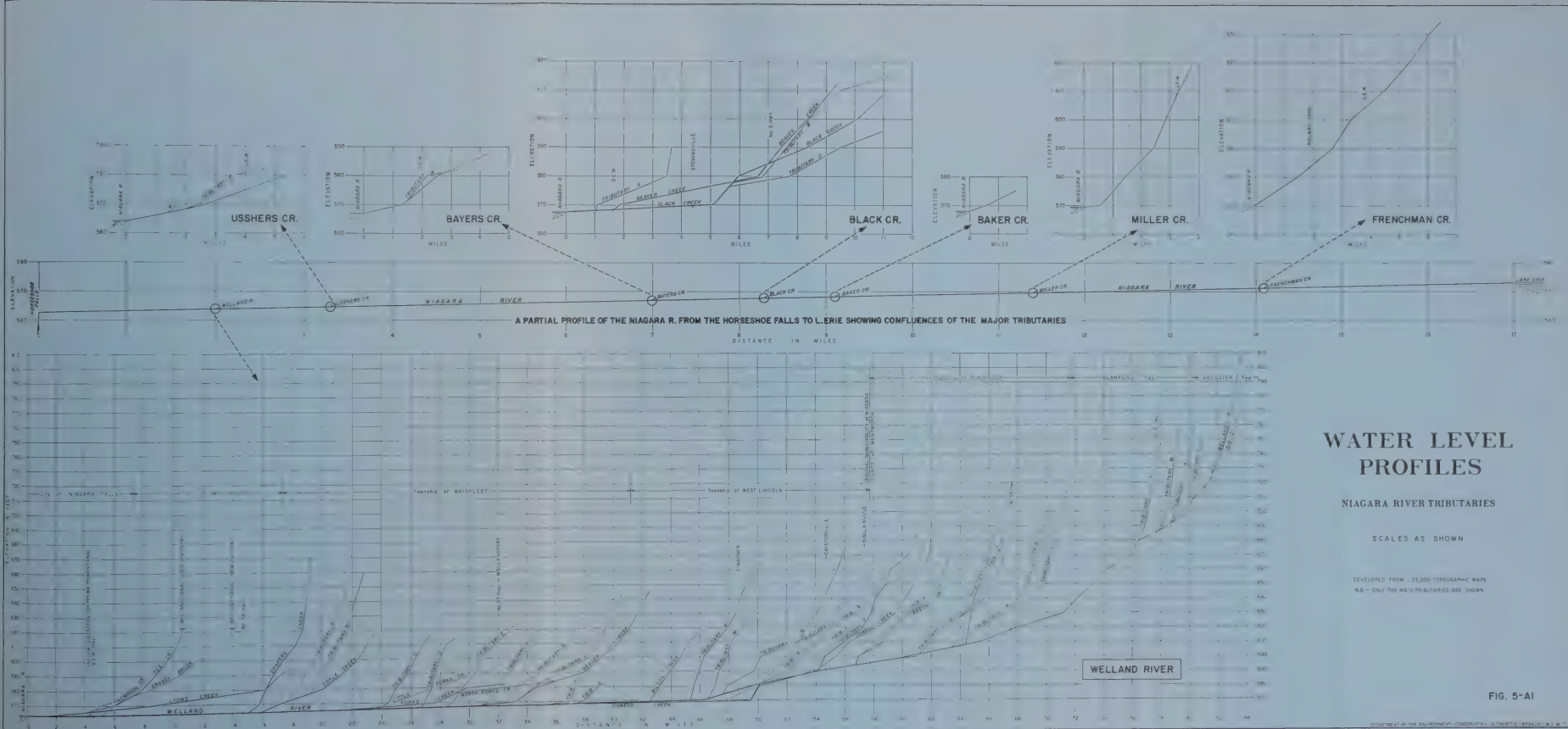
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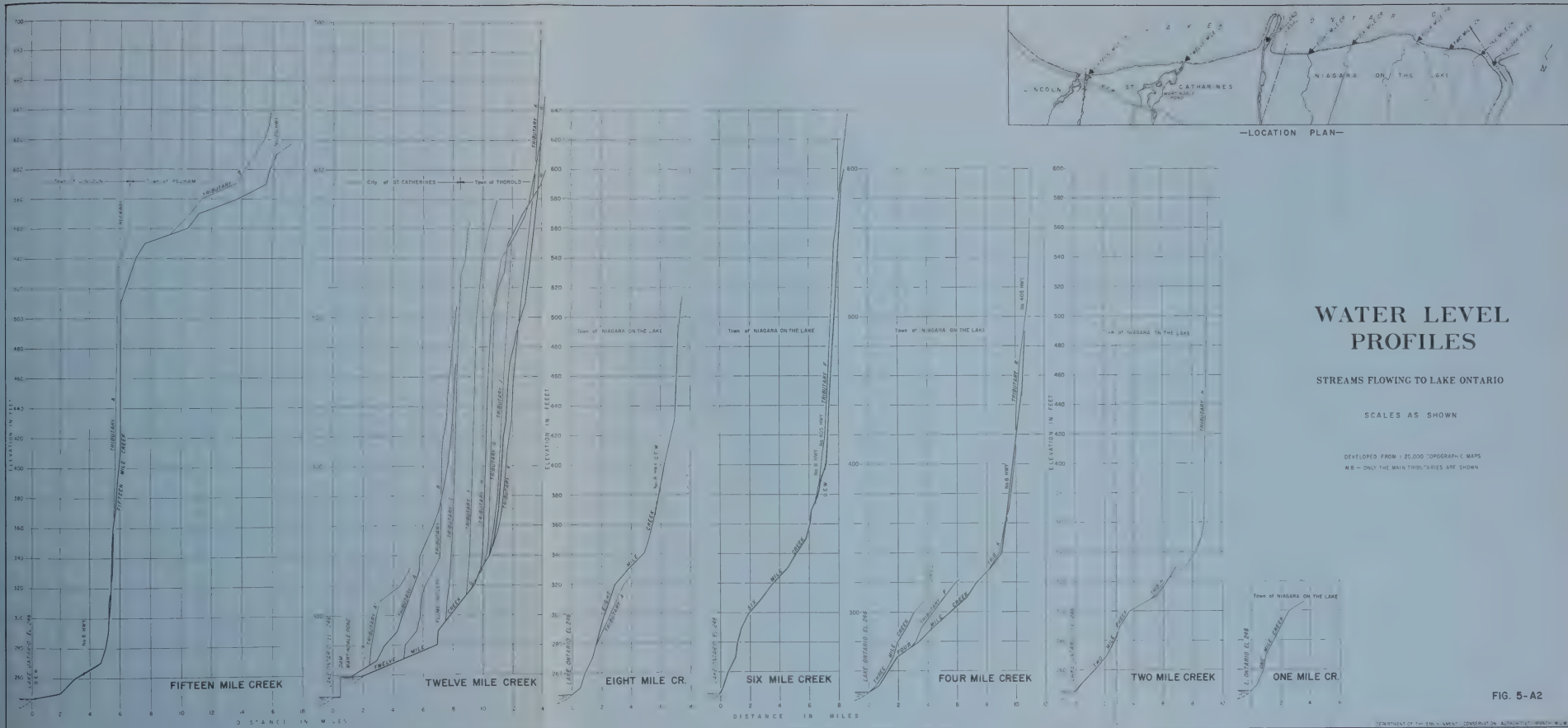
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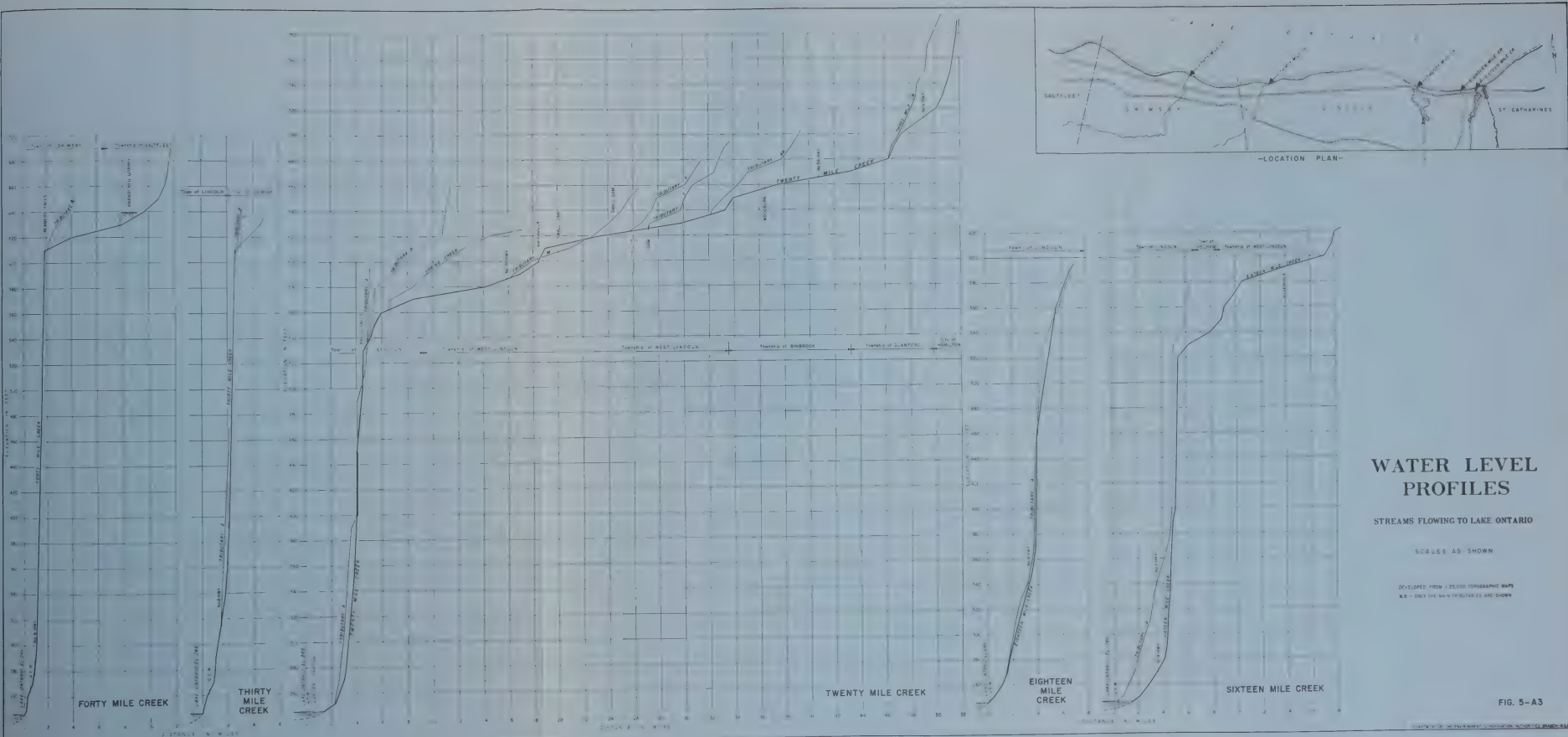
CITY OF HAMILTON



REFERENCE: CHAPMAN, J. J. & PUTMAN, D. THE PHYSIOGRAPHY OF SOUTHERN ONTARIO 2ND EDITION







Section A6

FISH AND WILDLIFE RESOURCES

Fish

The present list of species of fish substantiated by specimens or authentic records in the Niagara Region follows: the names and order follow those in an "Information Leaflet" on the fishes of Ontario, published by the Department of Ichthyology and Herpetology of the Royal Ontario Museum in 1968.

Species which are of interest to anglers are marked with an asterisk(*).

Fish of the Niagara Region

<i>Amia calva</i>	bowfin
<i>Dorosoma cepedianum</i>	gizzard shad
* <i>Salmo gairdneri</i>	rainbow trout
* <i>Salmo trutta</i>	brown trout
* <i>Salvelinus fontinalis</i>	brook trout
<i>Umbra limi</i>	central mudminnow
* <i>Esox lucius</i>	northern pike
<i>Couesius plumbeus</i>	lake chub
* <i>Cyprinus carpio</i>	carp
<i>Hybognathus hankinsoni</i>	brassy minnow
<i>Notemigonus crysoleucas</i>	golden shiner
<i>Notropis atherinoides</i>	emerald shiner
<i>Notropis cornutus</i>	common shiner
<i>Notropis hudsonius</i>	spottail shiner
<i>Opsopoeodus emiliae</i>	pugnose minnow
<i>Pimephales notatus</i>	bluntnose minnow
<i>Pimephales promelas</i>	fathead minnow
<i>Rhinichthys atratulus</i>	blacknose dace
* <i>Semotilus atromaculatus</i>	creek chub
<i>Semotilus margarita</i>	pearl dace
* <i>Catostomus commersoni</i>	white sucker
* <i>Ictalurus natalis</i>	yellow bullhead
* <i>Ictalurus nebulosus</i>	brown bullhead
* <i>Ictalurus punctatus</i>	channel catfish
<i>Noturus gyrinus</i>	tadpole madtom
<i>Fundulus diaphanus</i>	banded killifish
* <i>Ambloplites rupestris</i>	rock bass
* <i>Lepomis gibbosus</i>	pumpkinseed
* <i>Micropterus dolomieu</i>	smallmouth bass
* <i>Micropterus salmoides</i>	largemouth bass
* <i>Pomoxis annularis</i>	white crappie
* <i>Pomoxis nigromaculatus</i>	black crappie
* <i>Perca flavescens</i>	yellow perch
<i>Etheostoma nigrum</i>	Johnny darter
<i>Percina caprodes</i>	logperch
* <i>Aplodinotus grunniens</i>	freshwater drum

MUD LAKE CITY OF PORT COLBORNE

(FORMERLY HUMBERSTONE TWP.)

LEGEND

USEFUL VEGETATION FOR WATERFOWL

DENSITY OF VEGETATION

- OCCURS-----1
- SPARSE-----2
- COMMON-----3
- ABUNDANT OR DOMINANT---4

CHIEF VEGETATION

- DOGWOOD-----D
- LEMNA-----L
- POTAMOGETON²-----POT²
- POTAMOGETON¹-----POT¹
- TYPHA-----T
- WILLOW-----W
- WOODLANDS-----
- DUCK BLIND-----

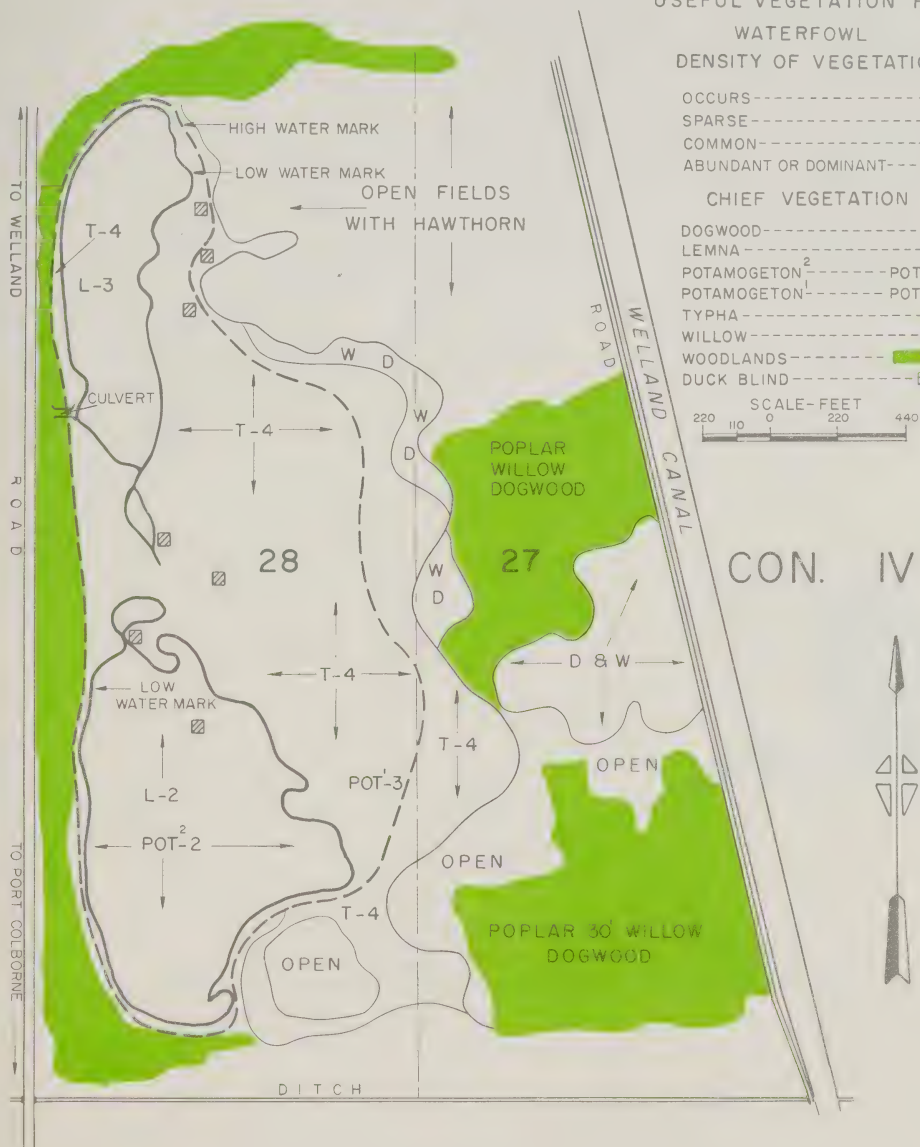








FIG. 6-A1

LYONS CREEK CITY OF NIAGARA FALLS

(FORMERLY CROWLAND TWP)
SHOWING WILDFOWL HABITAT

LEGEND

OPEN WATER 
WATER LIMIT PASSING THROUGH
SUBSTANTIAL 
CHIEF AQUATIC VEGETATION
CEPHALANTHUS
LEMNA + SPIRODELA
SPARGANIUM
TYPHA 
DENSITY OF VEGETATION
SPARSE
COMMON 
VERY COMMON 
ABUNDANT OR DOMINANT 

SCALE - FEET
0 100 200 400 600



FIG. 6-A2

PART THREE

SOCIAL AND ECONOMIC DEVELOPMENT

Section A9

GENERAL DESCRIPTION

Hazard Lands

The purpose of defining Hazard Lands is to provide a physical base on which environmental planning can take place. The need for environmental planning is obvious to those who are familiar with the Niagara Peninsula. It is a corridor through which many tourists travel. There is a wealth of diverse environmental amenities and these must be maintained for the enjoyment and benefit of future generations.

The Hazard Lands are shown in Figure 9-A1. The purpose of this mapping program was to determine those areas of the Niagara Peninsula Conservation Authority which possess inherent physical conditions such as poor drainage, organic soils, flood susceptibility, erosion, steep slopes or any other physical condition which could lead to the deterioration or degradation of environment under various land uses. These lands have been delineated so that suitable land management techniques can be employed. These may take the form of planning restrictions or remedial works. This information can serve as a useful and positive input for the Official Plan being prepared for the Regional Municipality of Niagara.

The Hazard Lands information was interpreted from aerial photographs taken in 1965 and transferred to 1:25,000 and 1:50,000 National Topographic Series Maps. This was augmented with information from the Ontario Land Inventory Maps, reports of commissions and other special purpose bodies. Field spot checks were used to check the air photo interpretation.

The Hazard Lands of the Conservation Authority are largely concentrated along the shorelines of Lakes Ontario and Erie and along the shorelines of Lakes Ontario and Erie and along the numerous ravines and the escarpment. Investigations show annual losses of shoreline in some places as great as seven feet. This would pose a definite and serious risk to any future urban development.

The ravines which are common throughout the Authority and provide surface runoff routes can serve purposes other than the Hazard Lands protection function. They have a multiple-use which can include recreational corridors, design buffers, and wildlife protection areas. The ravines from a very real environmental resource which must be protected.

The Niagara Escarpment which was considered in the Gertler Study completed in 1969 is shown on Figure 12-2. The top of the escarpment, where it is not pronounced, was defined as the 600-foot contour line. The Niagara Escarpment, including the steep slopes and talus deposits, is a physiographic feature which by definition is largely a Hazard Area.

Other environmental problems are identified on Figure 9-A1 and should be managed in the same strict way. These additional areas include swamps, marshes and very poorly drained soils.

In managing these Hazard Lands it is imperative that satisfactory separation be provided between the Hazard Lands and incompatible uses. Thus it is vital that building setbacks be established from the top of the shoreline bluffs based on the severity of the hazard and the establishment of protection works. For example, if a shoreline continued to erode at seven feet per year, a building setback of only 50 feet with no protection works would mean that within seven years the bank will erode back to the foundations of any buildings placed. Similarly, building setbacks will be necessary from the top of the Niagara Escarpment for physical protection of buildings from bank slippage and for aesthetic reasons.

CITY OF HAMILTON



HAZARD LANDS



Section A11

FOREST RESOURCES AND RELATED ACTIVITY

1. Extent and Nature of the Resource

a. *Forest Cover Types*

The term "Forest Cover Types" is used in a forest classification system and refers to those combinations of tree species occupying the ground, with no implication as to whether these types are temporary or permanent. A slightly modified form of the system drawn up by the Society of American Foresters was used in the survey of the Niagara Peninsula Conservation Authority.

The forest cover of the Authority was surveyed in 1970 by using a sampling method whereby typical blocks of land were studied. Coverage was expanded by using air photo interpretation.

Woodlots considered by their owner as a single entity were divided during the survey where there were clear differences between the type and age class found in them. Conversely, where property boundaries were not marked, as around the borders of bogs, cover types extending across property boundaries were considered as a unit because the species combination and age class remain constant throughout. Generally it can be said that much of the Authority's forest cover on private lands, when examined for its species content alone, exhibits a fragmentation of cover types.

A description of the main cover types in relationship to local site conditions follows:

i. *Dry Site Types*

Type 4: Aspen usually functions as a typical pioneer type of forest in Southern Ontario, appearing after clear cutting, over-grazing, or fire. Commonly it invades abandoned fields and pastures. It is sometimes considered a less valuable form of cover, yet it can have many uses. It grows on droughty soils as well as those that are wet throughout a good part of the year, although it avoids the wettest swamps. A sister type, poplar-oak (Type 4a), is frequently mapped in Southern Ontario, occupying similar acreages and sites. Aspen's associates may be largetooth aspen, red cherry, white elm, paper birch and balsam poplar, the latter sometimes forming pure stands on moist sites. An understorey of dogwood or spruce and balsam fir on wet sites, or tolerant hardwoods on drier sites, is frequently present.

Type 8: White pine-red oak-white ash is a type that quite often occurs on fairly warm and dry sites. It often follows white pine that establishes on old fields, and occurs also on land never cleared for agriculture. It may be permanent in some places but in general tends towards the white pine-hemlock type or the northern hardwood-hemlock group.

Type 9: White pine, although occupying a prominent economic position in Southern Ontario's forest area during the period of early settlement, now commonly occupies a lesser position. There is frequently the problem of low quality stems and form in present day natural stands.

White pine's associates on light soils are red pine, grey birch, black cherry, white ash, red oak, sugar maple, basswood and hemlock.

White pine is often the first type to occupy abandoned agricultural land. It approaches permanence on sandy soils. On heavier soils it is usually succeeded by sugar maple-beech-yellow birch, red oak-basswood-white ash, and white spruce-balsam fir-paper birch. It is considered to be a long-lived temporary type that seldom succeeds itself except after fires or under special cultural treatment.

Type 13: Sugar maple-basswood is another cover type that appears on rich upland loamy soils, hence has also experienced heavy clearing pressure in favour of agriculture.

It appears frequently on lakeshores. Along with the predominant species, white elm, yellow birch, white pine and red oak are to be found as associates.

Type 14: Sugar maple, and its related Type 57, beech-sugar maple, are commonly observed occupying locations in heavily developed agricultural areas. Both types favour deep, fertile, well drained soils with good moisture conditions. At times sugar maple stands may have a small component of yellow birch, white ash, red and white oak. They sometimes owe their vigour to cultural practices favouring maple syrup production and may also be found in small patches.

Both types have commonly experienced considerable cutting and clearing pressure since settlement.

Type 49: White oak-black oak-red oak cover type can be found on a variety of locations, such as lowland sites, gravelly morainal slopes, or on dry ridges. Type 49a (white oak-black oak-hickory) is somewhat similar to the previous mentioned type, except that hickory makes up a significant portion of the stand.

Type 50: White oak is commonly found on dry upland sites in small stands with white oak predominant over such associate species as red oak, bur oak, shagbark and bitter-nut hickory, white ash and largetooth aspen.

Type 51: Red oak-basswood-white ash as a cover type is usually observed on deep, fertile, moist, well drained soils. Its common associate species are red maple, yellow birch, the aspens, sugar maple, paper birch, and beech.

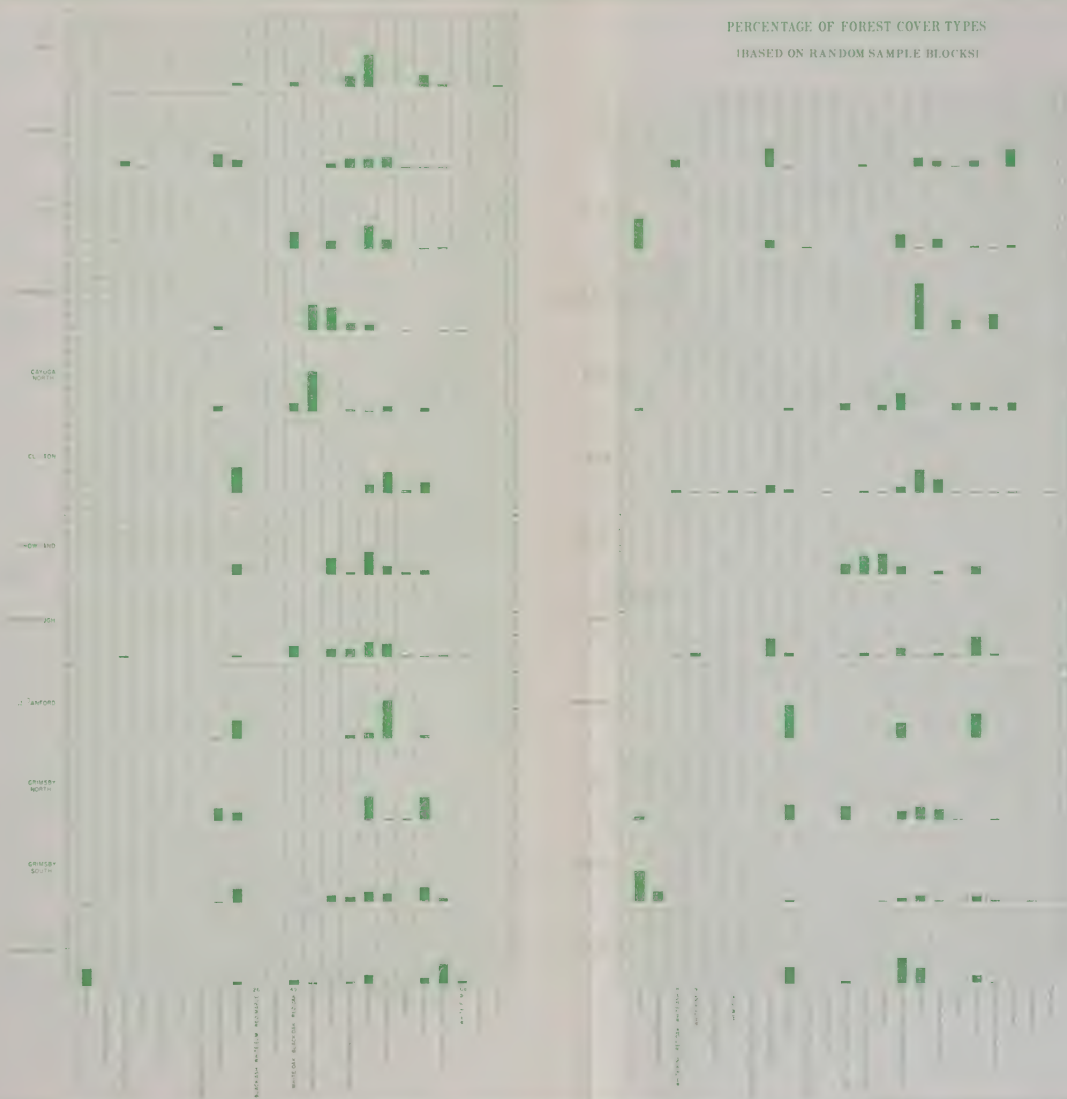
Type 52: Red oak commonly covers small acreages, tending to act as a pioneer species in Canada on warm dry sites. This may frequently happen in association with paper birch.

Type 59: Ash-hickory is a cover type found throughout the deciduous forest area on poorly drained soils. It may occur on any cut over area. The predominant species are white ash, hickory and white elm. It is not uncommon to observe stands with heavy components of either white ash or hickory.

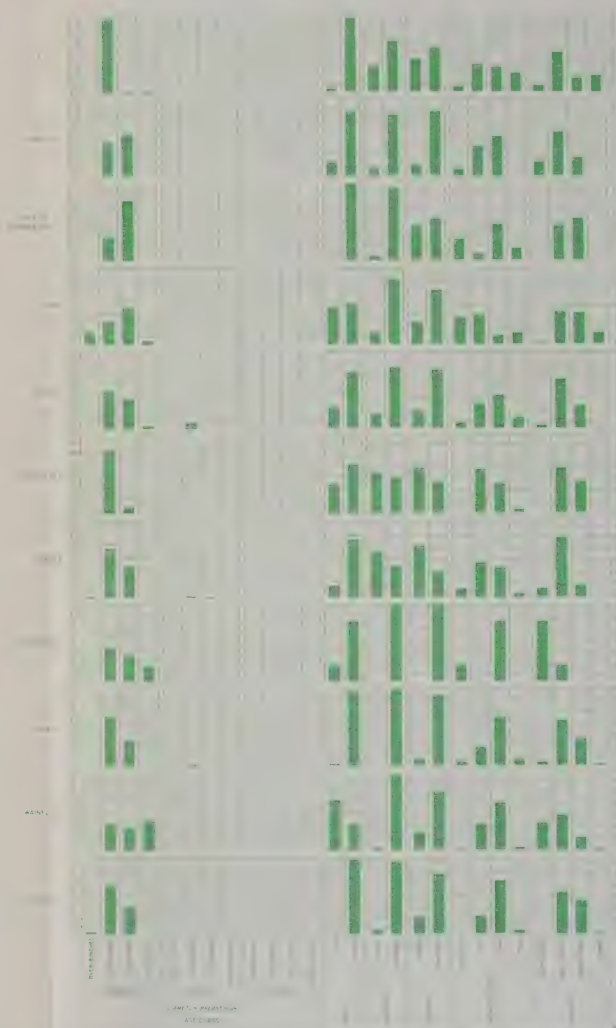
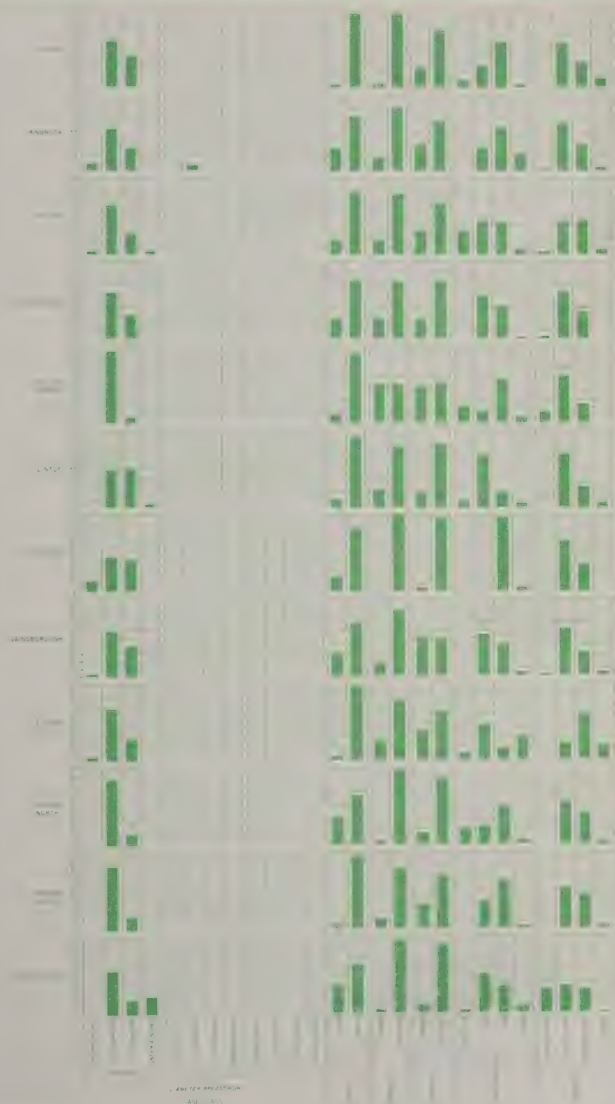
ii. Wet Site Types

Type 60: Silver maple-white elm and its closely related Type 60a, white elm, occurs on stream bottoms and on swampy depressions where the land is too wet for agriculture unless underdrained. Consequently, such stands are the cover that remained after forests were cleared for settlement, because of the difficulty of operating the site on which the elm stood. Elm, however, will also spread into dryer areas and it is a common hedgerow tree.

PERCENTAGE OF FOREST COVER TYPES
BASED ON RANDOM SAMPLE BLOCKS



BASED ON RANDOM SAMPLE BLOCKS!



PART FOUR

WATER AND RELATED LAND RESOURCE PROBLEMS

Section A19

POLLUTION

1. Municipal Wastewaters

The Niagara River, Welland River, Twenty Mile Creek, Welland Ship Canal, Lake Erie and Lake Ontario receive the discharges from municipal water pollution control plants.

Most of the treatment plants are discharging directly into Lake Ontario. All treatment plants in the near future will have (see Table A19-1) primary and secondary treatment facilities which will provide 90 per cent biochemical oxygen demand (BOD) and suspended solids removal.

The treatment plants of Niagara Falls and Fort Erie discharging into the Niagara River provide and will provide only primary treatment as the Niagara River has tremendous capabilities for self-purification.

The Welland WPCP with discharge into the Welland River provides only primary treatment. However, secondary treatment facilities are to be constructed in 1972 to improve the water quality of the river.

Table A19-1 shows the existing and proposed municipal water pollution control plants. The estimated waste discharges with respect to BOD and suspended solids and the sludge quantities are shown on Table A19-2.

The population projections shown on Table A19-3 are from the Servicing Master Plan for the Regional Municipality of Niagara. The approximate industrial population equivalents used in Table A19-2 are based on the industrial water consumption used in that report.

With the completion of the secondary treatment facilities for St. Catharines, Thorold and Welland the total BOD discharged into the receiving waters will be reduced from 52,147 lbs/day to 23,043 lbs/day. Similarly, the discharge of suspended solids will be reduced from 43,136 lbs/day to 21,240 lbs/day. However, the annual quantities of digested sludge will increase from 71,570 cu.yds. (44.4 ac. ft.) to about 145,600 cu. yds. (90 ac. ft.).

**Table A19-1: Existing and Proposed Municipal Water Pollution Control Plants
in The Regional Municipality of Niagara (Jan. 1971)**

Sanitary Sewer District	Date of Construction	Plant Capacity		Type of Treatment	Receiving Water Body	General Remarks
		Existing or Proposed	Ultimate			
District 1						
11 Grimsby WPCP	1947	Prim. Tr. 0.75 mgd *		Pri. & Sec.	Forty Mile Cr.	To be abandoned
		Sec. Tr. 0.45 mgd				
12 West Grimsby Sewage Lagoon	1965	5.9 ac.			Lake Ontario	
13 Grimsby Beach WPCP	1954			Trickl. Filter	Lake Ontario	To be abandoned
14 Beamsville WPCP	1953	0.2 mgd		Trickl. Filter	Lake Ontario	To be abandoned
15 Proposed Grimsby-Lincoln WPCP		2.5 mgd		Prim. & Sec.	Lake Ontario	To be constructed in 1972
District 2	1967					
21 Port Dalhousie WPCP	1970-71	9.0 mgd	18.0 mgd	Pri.	Lake Ontario	Sec. Treatment to be constructed in 1971
22 Port Weller WPCP		8.25 mgd		Pri. & Sec.	Lake Ontario	Under construction
District 3						
31 Town of Niagara Lagoons	1963	32.4 ac.			Lake Ontario	
32 Township of Niagara Lagoons (Garden City Raceway)		13.6 ac.				
District 4						
41 Niagara Falls WPCP	1963	10.0 mgd	20.0 mgd	Pri. Power Canal		
42 Chippawa WPCP	1957	0.3 mgd		Pri. & Sec.	Welland River	To be abandoned
43 Niagara Falls Lagoon					Welland River	To be abandoned
District 5						
51 Proposed Douglastown WPCP				Pri. & Sec.	Niagara River	To be constructed in 1972
District 6						
61 Fort Erie WPCP	1963	1.8 mgd	4.5 mgd	Pri.	Niagara River	
District 7						
71 Crystal Beach WPCP	1969	0.84 mgd	1.0 mgd	Pri. & Sec.	Lake Erie	To be extended to 1.0 mgd in 1972

* Million gallons per day

**Table A19-1: Existing and Proposed Municipal Water Pollution Control Plants
in The Regional Municipality of Niagara (Jan. 1971) - *continued***

Sanitary Sewer District	Date of Construction	Plant Capacity		Type of Treatment	Receiving Water Body	General Remarks
		Existing or Proposed	Ultimate			
District 8						
81 Port Colborne — West Side WPCP	1961	0.9 mgd*		Pri. & Sec.	Welland Canal	
82 Port Colborne — East Side WPCP	1956	0.85 mgd		Pri. & Sec.	Welland Canal	To be abandoned after 1975
District 9						
91 Welland WPCP	1968	8.0 mgd	16.0 mgd	Pri.	Welland River	10.0 mgd Sec. Treatment to be constructed in 1972
District 10						
101 Smithville Lagoon		8.52 ac.			Twenty Mile Creek	
District 11						
111 Proposed Lagoon I					No effluent	To be constructed prior to 1975
112 Proposed Lagoon II					No effluent	To be constructed prior to 1975
113 Proposed Lagoon III					No effluent	To be constructed prior to 1975

* Million gallons per day

Table A19-2: Estimated Municipal Waste Discharges and Sludge Quantities (1970 Conditions)

Urban Areas	Industrial Population Equivalent	Total Population Equivalent	Type of Treatment	BOD ₅ *		Suspended Solids		Annual Quantities of	
				Raw Sewage (lbs/day)	Effluent (lbs/day)	Raw Sewage (lbs/day)	Effluent (lbs/day)	Digested Sludge (cu. yd.)	Sludge (ac.ft.)
A) Discharging into Lake Ontario									
1 Grimsby	13,700	1,700	15,400 Pri. & Sec.	2,620	262	3,080	308	5,520	3.42
2 Beamsville	4,500	100	4,600 Pri. & Sec.	780	78	920	184	1,650	1.03
3 Vineland	1,700	—	1,700 Ind.	290	188	340	153	—	—
4 Jordan — Jordan Station	500	—	500 Ind.	85	55	100	45	—	—
5 St. Catharines	105,400	104,600	210,000 Pri.	35,700	23,200	42,000	19,000	25,600	15.90
6 Thorold	9,000	9,000	18,000 Pri.	3,060	2,000	3,600	1,620	2,200	1.37
7 Niagara-on-the-Lake	3,180	120	3,300 Lag.	560	112	660	132	—	—
8 Virgil	2,000	200	2,200 Ind.	374	243	440	198	—	—
9 St. Davids	500	—	500 Ind.	85	55	100	45	—	—
10 Smithville	1,200	50	1,250 Lag.	212	42	250	50	—	—
Subtotal	141,680	115,770	257,450	43,766	26,235	51,490	21,735	34,970	21.72
B) Discharging into Welland Ship Canal									
11 Port Colborne	21,500	1,500	23,000 Pri. & Sec.	3,900	390	4,600	460	8,250	5.12
12 Crystal Beach	2,180	—	C) Discharging into Lake Erie 2,180 Pri. & Sec.	370	37	436	44	780	0.48
13 Welland	43,600	39,600	D) Discharging into Welland River 83,200 Pri.	14,200	9,200	16,640	7,500	10,150	6.21
14 Fonthill	4,000	400	4,400 Ind.	746	485	880	396	—	—
Subtotal	47,600	40,000	87,600	14,946	9,685	17,520	7,896	10,150	6.21
E) Discharging into Niagara River									
15 Fort Erie	10,050	9,000	19,050 Pri.	3,230	2,100	3,810	1,720	2,320	1.44
16 Niagara Falls	64,000	60,000	124,000 Pri.	21,000	13,600	24,800	11,200	15,100	9.40
17 Queenston	850	50	900 Ind.	153	100	180	81	—	—
Subtotal	74,900	69,050	143,950	24,383	15,800	28,790	13,001	17,420	10.88
Total	287,860	226,320	514,180	87,365	52,147	102,836	43,136	71,570	44.41

* 5-day biochemical oxygen demand.

Assumed Criteria:	3	Digested Sludge Quantities (Daily)		
		Primary treatment	9 cu.ft./1000 persons	
		Complete treatment	26.5 cu.ft./1000 persons	
Loadings: $BOD_5 = 0.17$ lbs/cap/day	2	Treatment Efficiencies		
Suspended Solids = 0.20 lbs/cap/day		Removal (%)	Suspended Solids	
	Pri.	Primary treatment (settling)	35	55
	Ind.	Individual treatment (septic tanks)	35	55
	Lag.	Lagoons (waste stabilization ponds)	80	80
		Pri. & Sec. Complete treatment (activated sludge)	90	90

Table A19-3: Population Projections (according to Servicing Master Plan) for The Regional Municipality of Niagara

Urban Areas	1970	1980	1990
1 Grimsby (area below escarpment)	13,700	18,420	24,750
2 Beamsville	4,500	6,050	8,120
3 Vineland	1,700	2,200	2,900
4 Jordan — Jordan Station	500	650	850
5 St. Catharines	105,400	131,800	163,500
6 Niagara-on-the-Lake (former Town)	3,180	3,880	4,730
7 Virgil	2,000	2,440	2,970
8 St. Davids	500	610	740
9 Queenston	850	1,040	1,270
10 Niagara Falls	64,000	78,000	95,100
11 Thorold (former Town)	9,000	9,940	10,080
12 Fonthill	4,000	5,920	8,750
13 Smithville	1,200	1,460	1,790
14 Port Colborne	21,500	23,700	26,250
15 Welland	43,600	53,100	64,800
16 Crystal Beach	2,180	2,290	2,410
17 Fort Erie	10,050	11,330	12,760
Total	287,860	352,830	431,770
Growth Rate (%)		2.0	2.0

2. Industrial Wastewaters

The area of Niagara Peninsula is favourably located for the development of industry. Relatively inexpensive electric power and natural gas are available, as well as suitable water supplies. Transportation including rail, road and shipping facilities are well developed. In addition, the major markets of Southern Ontario are within a radius of 150 miles. As a result, industrial development has been extensive. Plants producing and processing steel, chemicals, pulp and paper, textiles, abrasives, food, etc., are located in the region. The major industrial centres are the Cities of St. Catharines, Welland and Niagara Falls and the Towns of Thorold, Port Colborne, Fort Erie, Grimsby and Lincoln.

Industrial wastewaters are only one cause of water pollution, but because of the volume of water used in industrial processing, and in some cases, the visible effects of industrial discharges on receiving streams, much public attention is focused on industry.

The industrial pollution control programs are carried out under the provisions set out in The Ontario Water Resources Commission Act.

The OWRC's Division of Industrial Wastes has been assigned three prime responsibilities:

1. Routine surveillance of all industries to ensure that measures are being taken towards the control and/or abatement of industrial pollution.
2. Review of all waste treatment proposals for new or expanding industries.
3. Provision of technical assistance to industries and municipalities in developing solutions for new and/or persistent waste treatment and disposal problems.

The guideline tables (see Table A19-4) to industrial waste problems are based on OWRC objectives. Where limits for specific constituents are given in this table, the concentrations shown apply to discharge of wastes directly to public watercourses via private or municipal storm sewers.

The Tables A19-5 to A19-12, based on information received from the Industrial Wastes Division of the OWRC, summarize the status of industrial wastewater treatment and control. In the tables, only those industries discharging process wastewaters directly to a watercourse are included, and only those process wastes discharged to a watercourse are described.

The data provided for the fruit canning industry were taken from 1969 survey results and the data for the paper mills were obtained from 1970-71 survey results.

The Niagara River, Welland River, Twelve Mile Creek, Welland Ship Canal, Lake Erie and Lake Ontario receive wastewater discharges from industries.

Twelve Mile Creek and its tributaries receive most of the industrial wastewaters. The (Second) Old Welland Canal, also called industrial wastes drain, represents the greatest concentration of pollution. Six paper mills discharge their wastes into the Old Welland Canal, running through the City of St. Catharines. The discharged wastes are highly coloured, malodorous, and putrescible, high in BOD suspended solids and coliform densities.

About 35.7 million gallons per day (m.g.d.), or 66.2 cubic feet per second (c.f.s.), of process wastewaters are discharged daily by the six paper mills. The BOD₅ loadings of the wastes is 223,000 lbs/day. This biochemical oxygen demand is about equivalent to the waste effluent of 1,300,000 persons. The process wastes contain also about 91,000 lbs/day (45.5 tons/day) of suspended solids which is equivalent to the waste effluent of about 450,000 persons.

According to the guidelines the concentrations for BOD₅ and suspended solids should not exceed 15 p.p.m. (mg/l).^{*} These parameters are exceeded by all the six mills and the average concentrations are 625 mg/l BOD and 256 mg/l suspended solids. Table A19-5 shows the individual waste flows and concentrations and comments provided by OWRC.

The seventh paper mill (Beaverwood Fibre Co. Ltd) is discharging its process wastes into Beaver Dams Creek which drains into Gibson Lake and from there into Twelve Mile Creek. The concentrations on BOD₅ and suspended solids are 253 mg/l and 665 mg/l, respectively, and also exceed the OWRC objectives. In addition, the process wastes of the Hayes-Dana Ltd. Drive-Drain Division and the Frame Division are also discharged into Beaver Dams Creek: See Table A19-6.

Six companies discharge their wastewaters directly into Twelve Mile Creek as shown on Table A19-7.

The Welland River receives wastewaters from industries in the Cities of Welland and Niagara Falls: See Table A19-8. The waste effluent of the six companies listed exceeds the OWRC objectives with respect to BOD, suspended solids, iron, ether solubles, cyanide, nitrogen and/or ammonia compounds.

Table A19-9 shows the industrial waste discharges into the Niagara River.

Five companies discharge their industrial wastes into the Welland Ship Canal as shown on Table A19-10.

The industrial waste discharges into Lake Erie and Lake Ontario are shown on the Tables A19-11 and A19-12 respectively.

A summary of the tables indicates that about 118.8 m.g.d. (220 c.f.s.) of process wastewaters, including 0.4 m.g.d. (0.8 c.f.s.) of seasonal wastewaters, are discharged into the watercourses and Great Lakes. The total BOD₅ loading is about 248,000 lbs/day of which about 9,000 lbs/day are from seasonal industries. The BOD population equivalent has been estimated at 1,460,000 persons of which 51,000 are from seasonal industries.

The total loading of suspended solids is about 146,600 lbs/day (73.3 tons/day) of which 1,200 lbs/day (0.6 tons/day) are from seasonal industries. The population equivalent has been estimated at 733,000 persons of which 6,300 are from seasonal industries.

^{*} p.p.m. mg/l – parts per million (milligrams per liter)

Industrial waste discharge into the Old Welland Canal at Winchester Avenue, St. Catharines.



Summary of industrial waste discharges into streams and lakes:

Total flow: 118.8 m.g.d. (220 c.f.s.)

BOD₅ 248,000 lbs/day

BOD population equivalent: 1,460,000 persons

Suspended solids (SS): 146,600 lbs/day

SS population equivalent; 733,000 persons.

Table A19-4: Guideline Tables to Industrial Waste Problems

Industry	Problems	Treatment	Recommended Maximum Concentration in Effluent	
Basic iron and steel	(1) Blast furnace gas scrubber systems — high suspended solids	Sedimentation	Suspended solids	— 15 ppm
	(2) Blast furnace coke liquors — high phenols, ammonia and cyanides	Phenol recovery or bio-oxidation. Ammonia recovery or neutralization. Cyanide oxidation.	Phenol	— 20 ppb
			NH ₃	— 1 ppm
			CN	— 0.1 ppm
			pH	— 5.5 to 10.6
			Ether solubles	— 15 ppm
			Fe — less than 1.6 ppm in receiving water	
	(3) Pickle acids	Neutralization or recovery.		
	(4) Rolling mill oils	Gravity separation		
Chemicals agricultural	Phosphate fertilizer gypsum sludge and acid wastewater, high fluorides and phosphates.	Neutralization with lime followed by sedimentation. In plant recovery of phosphates.	Suspended solids	— 15 ppm
			PO ₄	— 25 ppm
			F — less than 1.6 ppm in receiving water	
Inorganic	Acid wastewaters from acid plants, gypsum sludge and chlorides from soda ash plants, alkali and chlorides and mercury from electrolytic chlorine plants.	Neutralization and sedimentation. Recycling and recovery for high dissolved solids such as chlorides and inorganic toxic constituents such as mercury.	Suspended solids	— 15 ppm
			pH	— 5.5 to 10.6
			Chlorides	— 1500 ppm
			Sulphates	— 1500 ppm
Chemical organic	High phenolics from plastics manufacture. High latex, phenolics and COD from polymers manufacturing. High COD generally.	Gravity separation followed by chemical oxidation and/or biooxidation	Suspended solids	— 15 ppm
			BOD ₅	— 15 ppm
			Ether solubles	— 15 ppm
			Phenols	— 20 ppb

Table A19-4: Guideline Tables to Industrial Waste Problems - *continued*

Industry	Problems	Treatment	Recommended Maximum Concentration in Effluent	
Food processing	High BOD ₅ and suspended solids. Wide seasonal variations.	(a) screening sedimentation and biological treatment.	BOD ₅	— 15 ppm
		(b) spray irrigation with winter waste storage.	Suspended solids	— 15 ppm
		(c) ridge and furrow irrigation.		
		(d) septic tank and sub-surface disposal for many small plants.	In accordance with Department of Health regulations.	
		(e) disposal to municipal sewerage system.	Municipal by-law requirements in case (e).	
Metal working, plating and finishing	Acids, cyanides toxic metals, Cutting and machine oils.	(a) Chemical oxidation of cyanides, neutralization and precipitation of metals, ion exchange, gravity separation and/or chemical treatment for oil removal.	Cn pH Suspended solids Cu - Cr Ni Zn	— 0.1 ppm — 5.5 to 10.6 — 15 ppm — 1 ppm — 1 ppm — 1 ppm — 5 ppm
		(b) Disposal to municipal sewerage system after pretreatment as above.	Municipal by-law requirements in case (b).	
Mining and metallurgical	(1) Suspended solids from milling of ores (tailings) and from smelting gas scrubber systems.	Sedimentation and impoundment.	Suspended solids pH	— 15 ppm 5.5 to 9.5
	(2) Acidic wastes and dissolved metals from processing of high sulphide ores, including acid mine drainage and runoff from tailings disposal areas.	Neutralization and/or recirculation of acidic wastes.	Metals < maximum specified for each metal; i.e. Cu — 1 ppm Zn — 5 ppm Ni — 1 ppm	
	(3) Radioactive wastes from uranium mining.	Barium chloride treatment for removal of Ra ²²⁶ followed by sedimentation.	Ra ²²⁶	— 3pCi/litre

Table A19-4: Guideline Tables to Industrial Waste Problems - *continued*

Industry	Problems	Treatment	Recommended Maximum Concentration in Effluent	
Petroleum and petrochemicals	High waste volumes containing relatively low levels of oils, phenolics and sulphides plus small volumes of concentrated chemicals such as spent caustics.	(a) Steam and/or flue gas stripping of sulphidic and phenolic wastes followed by biological treatment.	Ether solubles	— 15 ppm
			Phenol	— 20 ppb
			Contract land disposal in accordance with Ontario Department of Health regulations. Deep well injection in accordance with Department of Energy and Resources Management regulations.	
		(b) Gravity separation of oily wastewaters.		
Pulp and paper	High waste volumes containing suspended bark and fibre from debarking and paper making operations. Wash waters and cooking liquors from pulping operations. Spent liquors and wash waters from bleaching processes. Taste and odour producing wastes from kraft cooking process.	(c) Neutralization and/or contract land disposal of spent caustics.		
		(d) Deep well injection of high strength wastes.		
		Sedimentation for suspended solids removal. In-plant recovery and wastewater re-circulation for pulp liquors and wash waters. Biological treatment for reduction of soluble BOD and possibly taste and odour components.	BOD ₅	15 — ppm
			Suspended solids	15 — ppm
Service industries (mainly transportation)	Oily wastewaters from maintenance shops, fuelling depots and washing platforms. High BOD wastes from tank car washings.	Gravity separation for oil removal. Disposal to municipal sewerage system.	Ether solubles	— 15 ppm
			Municipal by-law requirements in latter case.	
Tanning and rendering	High BOD ₅ and suspended solids wastes from hide washings. High pH, sulphide and high solids wastes from lime sulphide treatment of hides. Spent vegetable and chrome tanning liquors. High BOD, grease and suspended solids from rendering operations.	Gravity separation for grease and suspended solids removal usually followed by disposal to municipal sewerage system or spray and ridge and furrow irrigation. Chemical treatment via neutralization and/or chlorination practised in some cases.	BOD ₅	— 15 ppm
			Suspended solids	— 15 ppm
			Sulphide as H ₂ S	— 1 ppm
			Municipal by-law requirements for plants discharging to sanitary sewers.	

*These guidelines to unit operations and processes are based on Ontario Water Resources Commission objectives and revised in conjunction with the **Industrial Waste Division**. Where limits for specific constituents are given in this table, the concentration shown applies to discharge of wastes directly to public watercourse via private or municipal storm sewers. In applying these guidelines to actual situations, the plant location in relation to the nature and size of the receiving stream will always have to be taken into account before final acceptable pollution levels can be arrived at. The commission recently published a valuable booklet, "Guidelines and Criteria for Water Quality Management in Ontario" which gives valuable additional data on specific contaminants.

Table A19-5: Waste Discharges of Paper Mills into Old Welland Canal

Name and Location	Volume of Process		BOD ₅ Loadings*		Suspended Solids		Comments
	Waste Water Discharged (m.g.d.)†	(c.f.s.)**	(lbs/day)	(mg/l)++	Population Equivalent ¹ (lbs/day)	Population Equivalent ² (mg/l)	
Ontario Paper Company Ltd., Thorold	22.1	41.1	192,000	868	1,130,000	127	A three-stage waste treatment program has commenced. The program includes solids removal, concentration of the waste effluents, and incineration of the concentrated wastes to remove most of the foam and brown colour from the old Welland Canal. The clarifier for the first stage has already been installed.
Abitibi Provincial Paper Ltd.,	5.8	10.8	23,000	396	135,000	794	A clarifier for solids removal has been installed (the first at any Ontario mill) and investigations into improved solids removal are underway.
Kimberly Clark of Canada Ltd.,	3.0	5.6	2,500	83	14,700	356	Primary treatment facilities to be installed by the end of 1971.
Garden City Paper Mills Company Ltd., St. Catharines	2.0 - 2.5	3.7 - 4.6	1,700	68 - 85	10,000	52 - 65	pH: 2.2 — An announcement was made this summer that this mill will cease operations.
Domtar Fine Papers Ltd., St. Catharines	2.1	3.9	1,600	76	9,400	90	Primary treatment facilities to be completed by the end of 1971.
Domtar Construction Materials Ltd., Thorold	0.5	0.9	2,200	4,400	12,900	680	The recirculation of process waters and discharge to the municipal sanitary sewage system is under consideration.
	35.7	66.2	223,000	625	1,312,000	256	456,500

Population equivalents are based on:

1 0.17 lbs. of BOD per capita per day.

* 5-day biochemical oxygen demand

† million gallons per day

** cubic feet per second

++ milligrams per litre

2 0.20 lbs. of suspended solids per capita per day.

Table A 19-6: Industrial Waste Discharges into Beaver Dams Creek

Name and Location	Volume of Process		BOD ₅ Loadings			Suspended Solids			Iron		Comments
	Waste Water (g.p.d.)	(c.f.s.)	(lbs/day)	(mg/l)	Population Equivalent ¹	(lbs/day)	(mg/l)	Population Equivalent ²	(lbs/day)	(mg/l)	
1 The Beaverwood Fibre Co. Ltd., Thorold	3,600,000	6.7	9,100	253	53,500	24,000	665	120,000			External treatment facilities consist of a small settling lagoon. In-plant controls to reduce the suspended solids levels are under way. (UNSATISFACTORY)
2 Hayes-Dana Ltd. Drive-Drain Div., Thorold	250,000	0.46				140	56	700	18	7.2	Improved oil separation facilities being designed. (UNSATISFACTORY)
3 Hayes-Dana Ltd., Frame Div., Thorold	75,000	0.014				10	13.3	50			(SATISFACTORY)

Population equivalents are based on:

1 0.17 lbs of BOD per capita per day.

2 0.20 lbs. of suspended solids per capita per day.

Table A19-7: Industrial Waste Discharges into Twelve Mile Creek

Table A1-7-1: Industrial Waste Discharges into Twelve Mile Creek									
Name and Location	Volume of Process		BOD ₅ Loadings			Suspended Solids			Comments
	Waste Water		Population Equivalent ¹	(lbs/day)	(mg/l)	(lbs/day)	(mg/l)	Population Equivalent ²	
	(g.p.d.)	(c.f.s.)							
1 Barnes Wines Ltd., St. Catharines	30,000 to 50,000 (seasonal)		230	767 to 460	50	167 to 100	250	pH: 3.0 – 7.6	The solution will be a connection to the municipal sanitary sewers when available. The sewer is scheduled to cross Twelve Mile Creek within the next year. (UNSATISFACTORY)
2 Canadian Cannerys Ltd., St. Catharines	250,000 to 300,000 (seasonal)		6,000 to 8,000	2,400 to 2,700	1,000	400 to 333	5,000		Over the past few years the company has carried out an extensive research program to select a practicable waste treatment system. The study is complete and a satisfactory solution to the problem must now be chosen. One possibility involves pretreatment and discharge to the sanitary sewers. (UNSATISFACTORY)
3 Tregunno Niagara Farms Ltd., Pelham						Normally Land Disposal But Overflows Occur Intermittently			Improved operating procedures of the waste disposal facilities are required (UNSATISFACTORY)
4 Grantham Packers Ltd., St. Catharines	5,400		170	3,150	50	925	250	Ether solubles 7 lbs/day, 130 mg/l	The solution to the problem consists of connecting to the municipal sanitary sewer system. (UNSATISFACTORY)
5 Hayes-Dana Ltd. Forge Div., St. Catharines	80,000				20	25	100		Treatment consists of an oil removal and settling pond. (UNSATISFACTORY)
6. Exolon Company, Thorold	2,000,000	3.7						pH:8.0	Water is used primarily for cooling purposes. (SATISFACTORY)

Population equivalents are based on:
 1 0.17 lbs of BOD per capita per day.
 2 0.20 lbs of suspended solids per capita per day.

Table A19-8: Industrial Waste Discharges into Welland River

Name and Location	Volume of Process Waste Water		BOD ₅ Loadings		Suspended Solids			Other Parameters	Comments
	(g.p.d.)	(c.f.s.)	(lbs/day)	(mg/l)	Population Equivalent ¹	(lbs/day)	(mg/l)	Population Equivalent ²	
1 Cyanamid of Canada Ltd. (Welland Plant), Niagara Falls	9,000,000	16.7	1,000 to 2,000	11 to 22	5,900 to 11,800	10,000 to 20,000	110 to 220	50,000 to 100,000	An OWRC industrial wastes survey was completed at this plant this summer. The report will include Ammonia compounds 4,000 lbs/day = 44 mg/l recommendations for corrective action. (UNSATISFACTORY) Cyanide 20 lbs/day = 0.22 mg/l Coagulation being used to improve efficiency of settling lagoon. Pilot Plant work on coagulation and Biological treatment continues. (UNSATISFACTORY)
2 B.F. Goodrich Canada Ltd., Niagara Falls	130,000	0.24	100	77	590	100	77	500	A comprehensive waste treatment study is underway. Oil spills have occurred. A corrective program is to be discussed during October 1970. (UNSATISFACTORY)
3 Atlas Steels Ltd., Welland	7,500,000	13.9	5,000	67	29,400				Iron 1,600 lbs/day = 21.3 mg/l
4 Ford Motor Co. of Canada Ltd., Niagara Falls	250,000 to 450,000		110	44 to 25	650	280	112 to 62	1,400	A waste treatment proposal is to be submitted to the OWRC for approval with construction to take place during the winter.
5 Norton Company, Niagara Falls	6,000,000	11.1				8,000	133	40,000	A treatment system involving settling and chemical treatment is under development for installation during the first half of 1971. The largest portion of the water used is for cooling purposes. (UNSATISFACTORY)

Table A19-8: Industrial Waste Discharge into Welland River - *continued*

Name and Location	Volume of Process Waste Water (g.p.d.)	BOD ₅ Loadings		Suspended Solids		Population Equivalent ²	Other Parameters	Comments
		(c.f.s.)	(lbs/day)	(mg/1)	(lbs/day)			
6 Welland Tubes Works, Welland	100,000		20	20	50	25	Ether solubles 40 lbs/day = 40 mg/1	Existing treatment consists of a scale pit and lagoon. Improvements are required, discharge to sanitary sewers (after ship canal relocation) being considered. (UNSATISFACTORY)
					Lyons Creek			
					120			

Population equivalents are based on:

1 0.17 lbs of BOD per capita per day.

2 0.20 lbs of suspended solids per capita per day.

Table A19-9: Industrial Waste Discharges into Niagara River

Name and Location	Volume of Process Waste Water (g.p.d.)	BOD ₅ Loadings			Suspended Solids			Other Parameters	Comments
		(c.f.s.)	(lbs/day)	(mg/l)	(lbs/day)	(mg/l)	Population Equivalent ²		
1 Riverdale Frozen Foods Ltd. Niagara Falls	60,000			low		low			Treatment facilities installed during 1970 have not been evaluated but are expected to be satisfactory. Water is used primarily for cooling.
2 Cyanamid of Canada Ltd. (Niagara Plant), Niagara Falls	17,000,000	31.5		nil		nil			(SATISFACTORY)
3 Canadian National Railways, Fort Erie	Variable with rainfall							Ether Solubles: 7 mg/l	Oil has been a problem in the past. Improved oil separation devices have been installed.
4 Fleet Manufacturing Co Ltd. Fort Erie	80,000				16	20	80	Small quantities of chromium and nickel	(SATISFACTORY)
5 Gould National Batteries of Canada Ltd., Fort Erie	14,000				15	107	75	Small quantities of lead	Improvements to the neutralization and lead removal system are being devised.

Population equivalents are based on:

1 0.17 lbs of BOD per capita per day.

2 0.20 lbs of suspended solids per capita per day.

Table A19-10: Industrial Waste Discharges into Welland Canal

Name and Location	Volume of Process Waste Water (g.p.d.)	BOD ₅ Loadings			Suspended Solids			Other Parameters	Comments
		(c.f.s)	(lbs/day)	(mg/l)	Population Equivalent ¹	(lbs/day)	(mg/l)	Population Equivalent ²	
1 Robin Hood Flour Mills Ltd., Port Colborne	10,000		10	100	58	13	130	65	The minor problem is difficult to resolve. The waste volume and loadings have been reduced to 25% of their former values by converting wet grain washing to dry cleaning methods. Remaining wastes will likely be handled at the municipal WPCP.
2 Union Carbide Canada Ltd., Welland	4,000,000 to 5,000,000	7.4 to 9.2		low			low		Water is used primarily for cooling purposes.
3 John Deere Co. Ltd., Welland	40,000			low			low		Cooling water is discharged to the Welland Canal.
4 The Steel Co. of Canada Ltd., Page-Hersey Works, Welland	2,000,000	3.7	160	8	940	1,200	60	6,000	Comprehensive waste treatment works are being designed for completion by early 1972.
5 General Motors of Canada Ltd., Plant No. 2, St. Catharines	6,000,000	11.1		low					Ether Solubles: 150 lbs/day = 7.5 mg/l (UNSATISFACTORY)

Population equivalents are based on:

1 0.17 lbs of BOD per capita per day.

2 0.20 lbs of suspended solids per capita per day.

Table A19-11: Industrial Waste Discharges into Lake Erie

Name and Location	Volume of Process Waste Water		BOD ₅ Loadings		Suspended Solids		Population Equivalent ²	Other Parameters	Comments
	(g.p.d.)	(c.f.s.)	(lbs/day)	(mg/1) low	(lbs/day)	(mg/1) low			
1 Harchem Ltd., Fort Erie	Small volume								
2 Algoma Steel Corp. Ltd. (Canadian Furnace Div.), Port Colborne	16,000,000	29.6			1,200	7.5	6,000	Iron: 12 lbs/day = 0.075 mg/1	Contaminated wastes trucked to Fort Erie WPCP Treatment consists of neutralization and settling. (Operates only part of each year). (SATISFACTORY)
3 The International Nickel Co. of Canada Ltd. Port Colborne	8,000,000	14.8			4,000	50	20,000	Copper: 200 lbs/day = 2.5 mg/1 Nickel: 480 lbs/day = 6 mg/1	In-plant control and external neutralization and settling on part of the flow is performed. Improved control procedures are required. (UNSATISFACTORY)

Population equivalents are based on:

1 0.17 lbs of BOD per capita per day.

2 0.20 lbs of suspended solids per capita per day.

Table A19-12: Industrial Waste Discharges into Lake Ontario

Name and Location	Volume of Process Waste Water		BOD ₅ Loadings		Suspended Solids			Other Parameters	Comments
	(g.p.d.)	(c.f.s.)	(lbs/day)	(mg/l)	Population Equivalent ¹	(lbs/day)	(mg/l)		
						Direct Discharge			
1 Arkell Foods Ltd., Grimsby	30,000 (seasonal)		800	2,650	4,700	80	265	400	Discharge in small creek waste water now held for spring discharge. Aeration and discharge to municipal sanitary sewer under consideration. (UNSATISFACTORY)
2 Andres Windes Ltd., Grimsby									Information not available
3 Culver House Canning Ltd., Lincoln (Vineland)	80,000 (seasonal)		160-1200	200-1500	940-7100	30-200	37-250	150-1000	Present disposal is by extended outfall to Lake Ontario. Pretreatment of the wastes is to be provided before the 1971 canning season. Ultimate discharge of the treated wastes to a municipal system is also being considered. (UNSATISFACTORY)
4 Jordan Wines Ltd., Lincoln (Jordan)									
5 Canadian Cannery Ltd. Niagara-on-the-Lake				low		Four Mile Creek	low		Treatment consists of impoundment spray irrigation and a seasonal discharge meeting OWRC objectives. (SATISFACTORY)
6 Moyer Sand (1967) Ltd., Pelham						Twenty Mile Creek			To be surveyed.
7 Lake Foundry and Machine Co., Grimsby	10,000			low		Forty Mile Creek	low		Water used primarily for cooling purposes. (SATISFACTORY)

Population equivalents are based on:

1 0.17 lbs of BOD per capita per day.

2 0.20 lbs of suspended solids per capita per day.

3. Agricultural Pollution

Agricultural soil and water pollution may have the following sources:

1. human wastes from farm population,
 2. farm animal wastes,
 3. crop residues,
 4. residues from agricultural chemicals such as fertilizer and pesticides and other control agents and
 5. dead domestic and wild animals.
- Farm animal wastes, chemical fertilizer and pesticides are the major sources.

a. *Farm Animal Wastes*

Until recently, farms have not been considered a serious source of air and water pollution. In the last decade, however, drastic changes in the methods of producing farm animals for slaughter and for food products have been experienced. The production of animals has emerged from the small, individual farm operation into a large scale industrial enterprise involving hundreds of acres and thousands of animals.

With today's large scale poultry production, confinement housing is the major method for meat and egg production, and large scale confinement swine and beef operations are rapidly approaching the intensity of the poultry industry.

The farming industry needs farm animal waste management for the following reasons:

1. Specialization of farm operations has increased the concentrations of manure production.
2. Confinement housing has led to concentration of manure and significant changes in manure characteristics and, in particular, the trend towards liquid manure handling systems.
3. Cheaper and more manageable commercial fertilizers have reduced the demand for manure as a fertilizer.
4. Urban sprawl and farm area encroachment have brought more people into close contact with the environmental problems.

To appreciate the difficulties, it must be realized that 500,000 chicken broilers, 50,000 laying hens, 5,000 market hogs, 1,000 beef cattle or 500 dairy cattle generate a manurial waste comparable to the human excrement (not including garbage and other wastes) produced by a city of 10,000 people.

Confinement housing is perhaps the major factor in the creation of the immense waste disposal problem as feed and water are brought to the animals and no longer do they drop their manure on pastures where it can be absorbed naturally. Instead, the wastes must be collected, stored and disposed.

The livestock or poultry farmer, generally, is not crop farming. He, therefore, relies on commercially available food supplements for a considerable portion of his feeding requirements, and thus, he frequently does not have adequate land of his own for the disposal of all the animal wastes. The crop farmer, on the other hand, can usually buy and apply chemical fertilizers more cheaply than he can use free animal manure.

During the late 1950s and early 1960s, chicken broiler production surged upward in the Niagara Peninsula and by 1965 the former County of Lincoln was acknowledged as the largest producer of chicken broiler meat in Ontario.

When prices for chicken broilers dropped in the sixties, turkey broilers appeared as an attractive alternative, and now the former County of Lincoln is also the leading turkey broiler producer in Ontario.

The annual manure production within the boundaries of the Regional Municipality is shown on Table A19-13. The production is about 813,500 cu.yds. per year or 2,230 cu.yds. per day. This quantity is equivalent to the human excrement of about 1,200,000 persons

and the produced animal manure has a pollution potential of about 890,000 persons measured as BOD.

The total fertilizer value of the produced animal manure in the area of the Regional Municipality is about \$1,500,000 or about \$1.98 per cu.yd. as shown on Table A19-14.

The fertilizer value for the different types of manure is about:

poultry	\$4.15/cu. yd.
swine	\$1.85/cu. yd.
cattle	\$1.40/cu. yd.

Table A19-15 indicates the relationship among the various animal species of different ages in terms of their potential to cause pollution problems through their waste production.*

Considering the present number of animals housed or marketed per year a minimum of about 32,200 ac. (49 sq. mi.) of tillable loam soil are required for the waste disposal. For sandy soil the minimum requirement is 46,800 ac. (73.5 sq. mi.)

i. Pollution Potentials

At the present time, the manure disposal is not or is insufficiently controlled. Manure can cause air and soil pollution, the spread of insect pests and disease vectors, and weed propagation and dispersion. Of primary concern today, however, is the water pollution aspect which occurs in the form of oxygen demanding materials, toxic substances, nutrient materials and pathogenic organisms.

The biochemical oxygen demand (BOD) of animal manures is extremely high. Such high oxygen demanding wastes upon entering streams can cause oxygen depletion resulting in serious fish kills and long-term ecological changes. As a result, the aesthetic as well as the practical value of the watershed will be affected.

Excessive concentrations of nitrates in ground water used for drinking purposes may be biologically converted to nitrites in the digestive system and can cause methemoglobinemia (blue babies). They are also toxic to livestock. Animal manure can be a major source of nitrates in ground water and the importance of its contribution must be considered.

With the present emphasis on eutrophication, the nutrient contribution of farm animal wastes to surface waters is well recognized. Nitrogen and phosphorus are the principal elements involved, but other plant nutrients are also important. Farm animal wastes contain virtually all of the macro-nutrients as well as the trace elements required to promote algae growth.

Organisms, pathogenic to humans, animals and poultry, may be present in the manures from farm animals. These agents may be transported in surface and ground waters. Therefore, all waters receiving farm animal waste runoff must be considered as potentially dangerous to the health of humans and livestock.

ii. Existing Problems

1. Pollution of ground water and surface streams increases. Odours from livestock farms are creating social problems. This occurs throughout the year, mainly in the summer months, but particularly when manure is being spread on the land which has become much more evident since the adoption of liquid manure handling systems.
2. Property value decreases for residential use due to livestock and poultry barns placed in close proximity to farm and non-farm residence.
3. Livestock production units are established on small acreages that have neither the capacity to produce a sizeable portion of the feed to be used in the operation nor with

* *A Suggested Code of Practice* – The Department of Energy and Resources Management and the Department of Agriculture and Food.



Severe biological damage may result from the cleaning of agricultural spraying equipment in natural waters.

any regard to the acreage of land required for the economical use of manure in crop production. Waste disposal is a major problem.

b. Chemical Fertilizer

The application of animal wastes as fertilizer, as discussed under *a.*, presents a problem in managing the high nutrient content of these wastes. Chemical fertilizer is another source to provide nutrients to the agricultural land and can be of great benefit if properly applied. On the other hand, if over-used, the chemical fertilizer can lead to ground-water and surface-water pollution.

The nutrients which cause the most concern in lake eutrophication are phosphorus and nitrogen. These fertilizer nutrients may enter the water by:

1. leaching through the soil to the ground water, or
2. being carried either in solution or adhering to soil particles by surface runoff.

Table A19-13: Manure Production in the Regional Municipality of Niagara

Livestock	Animals Housed	Period of Confinement (days)	Animals Housed or Marketed Per Year	Manure Animal (g.p.d.)	Annual Manure Production		Minimum Area (ac.) Required for Waste Disposal		BOD (Persons/ (Population Animal) Equivalent)		
					Manure (mg)	(ac-ft) (cu.yd.)	Loam Soil	Sandy Soil	Animal	Equivalent)	
Poultry:											
Broiler Chickens	2,247,000	70	9,000,000	0.0027	8.90	32.7	52,600	4,500	6,750	0.015	135,000
Laying Hens	713,000	365	713,000	0.026	6.75	24.8	40,000	3,560	5,350	0.133	95,000
Pullets	10,000	160	20,000	0.009	0.07	0.3	400	40	60	0.04	400
Broiler Turkeys	1,021,000	85	3,060,000	0.009	10.00	36.8	59,500	5,100	7,650	0.04	122,400
Swine:											
Market Hogs	26,725	175	53,500	0.50	9.75	36.0	57,200	2,680	4,020	3.2	171,000
Sows	4,074	365	4,074	2.00	3.00	11.0	17,800	510	765	12.8	52,000
Cattle:											
Dairy Cows	18,350	365	18,350	9.5	63.50	233.0	378,000	9,170	13,750	12.8	236,000
Beef Cattle	18,340	365	18,340	4.7	31.50	116.0	187,000	4,580	6,870	3.75	69,000
Other:											
Horses	1,200	365	1,200	4.7	2.10	7.7	12,500	600	900	3.7	4,500
Sheep	3,600	365	3,600	1.2	1.60	5.9	9,500	450	675	1.5	5,400
					137.17	504.2	813,500	31,190	46,790		890,700

Table A19-14: Fertilizer Value of Produced Animal Manure in the Regional Municipality of Niagara

	Animals Housed or Marketed Per Year	Nutrient Material in Manure (lbs./year/animal)			Annual Nutrient Production (tons)			Fertilizer Value (\$)			
		Nitrogen	Phosphate	Potash	Nitrogen	Phosphate	Potash	Nitrogen (\$200/ton)	Phosphate (\$200/ton)	Potash (\$100/ton)	Total
Livestock											
Poultry:											
Broiler Chickens	9,000,000	0.15	0.07	0.06	675	315	270	135,000	63,000	27,000	225,000
Laying Hens	713,000	1.25	1.00	0.55	445	356	196	89,000	71,200	19,600	179,800
Pullets	20,000	0.45	0.21	0.18	4.5	2.1	1.8	900	420	210	1,530
Broiler Turkeys	3,060,000	0.45	0.21	0.18	690	320	275	138,000	64,000	27,500	229,500
Swine:											
Market Hogs	53,500	11.5	6.5	4.0	308	174	107	61,600	34,800	10,700	107,100
Sows	4,074	46.0	26.0	16.0	93	53	32.5	18,600	10,600	3,250	32,450
Cattle:											
Dairy Cows	18,350	140.0	65.0	175.0	1,285	595	1,600	257,000	119,000	160,000	536,000
Beef Cattle	18,340	70.0	32.5	87.5	642	297	800	128,400	59,400	80,000	267,800
					4,142.5	2,112.1	3,282.3	828,500	422,420	328,260	1,579,180

Table A19-15: Animal Units (Based on Pollution Potential)

1 dairy cow = 1 animal unit	(365 days)
1 beef cow = 1 animal unit	(365 days)
2 beef steers = 1 animal unit	(365 days) (500-1,200 lbs.)
1 bull = 1 animal unit	(365 days)
10 market hogs = 1 animal unit	(175 days) (30-200 lbs.)
4 dry sows = 1 animal unit	(365 days)
100 laying hens = 1 animal unit	(365 days)
1,000 chicken broilers = 1 animal unit.	(70 days)
300 pullets = 1 animal unit	(160 days)
300 turkey broilers = 1 animal unit	(85 days)
1 horse = 1 animal unit	(365 days)
4 mature sheep = 1 animal unit	(365 days)

Table A19-16: Minimum Acreage Requirements for Waste Disposal

Number of animal units housed or marketed per year (which- ever is greater)	Minimum acreage for livestock or poultry production	
	Loam Soil	Sandy Soil
40	40	40
41-60	40	45
61-80	40	60
81-100	50	75
101-120	60	90
121-140	70	105
141-160	80	120
161-180	90	135
181-200	100	150
201-220	110	165
221-240	120	180
241-260	130	195
261-280	140	210
281-300	150	225
301-320	160	240
321-340	170	255
341-360	180	270
361-380	190	285
381-400	200	300

Notes

- 1 The recommended land areas refer to tillable acres.
- 2 The recommended acreages are not necessarily the most economical from the standpoint of fertilization for efficient crop production. When this aspect is considered, the acreages may be doubled.
- 3 Minimum acreage requirements are indicated for loam and sandy soil, as examples. Other main soil types would have corresponding minimum acreage requirements.
- 4 The minimum acreages are those required to avoid risk of ground water pollution by compounds of nitrogen.
- 5 All calculations are on an annual basis.

4. Stream Water Quality

- a. Streams Discharging into Lake Ontario
 - i. One Mile Creek

The One Mile Creek, flowing through the Town of Niagara-on-the-Lake, is heavily polluted. Stream samples taken at the Niagara Boulevard (stream mileage 0.1) from Oct. 1965 to Dec. 1969, as indicated on Table A19-17 showed BOD concentrations up to 18.0 mg/l and dissolved oxygen (DO) values as low as 0.5 mg/l. The coliform density was up to 1,870,000 organisms per 100 millilitre (ml). The concentrations on nutrients (phosphorus and nitrogen) are also very high. The stream pollution originates mainly from inadequate and defective septic tank and tile bed systems.

ii. Two Mile Creek

Samples taken from Oct. 1965 to Dec. 1969 at the Lakeshore Road show that the stream is polluted. Table A19-18 shows BOD concentrations up to 4.6 mg/l, and DO values as low as 3.8 mg/l and coliform counts up to 149,000/100 ml. DO samples taken in the daytime show up to 150 per cent supersaturation (12 mg/l at 22 degrees C.) which indicates that excessive algae growths exist and that DO levels at night-time may be well below the objective of not less than 5 mg/l. Phosphorus and nitrogen concentrations, are also high. The stream pollution is most likely caused by inadequate and defective septic tank and tile bed systems, livestock operation and agricultural runoff.

The water samples shown on Table A19-19 are taken from the OWRC Report on the Water Pollution Survey of the Township of Niagara.

iii. Three Mile Creek

Only two water samples were taken in 1964 for the above report – see Table A19-20. At that time the excessive BOD concentration of 6.2 mg/l at stream mileage TH 1.4 at Hunter Road was suspected of being caused by a defective septic tank and tile bed system from the nearby school.

iv. Four Mile Creek

Twelve stream samples were collected in 1964 for the OWRC Report as shown on Table A19-21. The plant of the Canadian Cannery Ltd. at St. Davids was not operating at the time of sampling which would indicate that the pollution detected may be attributed to domestic sources.

The water samples from Oct. 1965 to Dec. 1969 were taken at four locations: Lakeshore Road (stream mileage F 0.5), Third Line (F 4.6), Seventh Line (F 7.0) and Ninth Line (F 8.2).

Four Mile Creek from St. Davids to Lake Ontario is grossly polluted as indicated on Tables A19-22 to A19-25. BOD concentrations up to 420 mg/l (Nov. 3, 1965) were recorded at Seventh Line. DO levels were down to 1.2 mg/l, and the maximum coliform counts were 11,000,000/100 ml. DO samples taken in the daytime show up to 153 per cent supersaturation (13 mg/l at 24 degrees C.) which indicates that excessive algae growths exist and that DO levels at night-time may be well below the objective of not less than 5 mg/l due to respiration by the algae. The phosphorus and nitrogen concentrations are, at times, very high.

The samples support the findings of the 1964 OWRC report that houses in St. Davids and Virgil, as well as other houses near the creek, discharge insufficiently treated wastes from septic tank and tile bed systems. It also appears that at times wastes from the cannery reach the creek during prolonged wet periods and the poor percolation qualities of the clay soil. Pollution from livestock and agricultural operations may also occur. There seems to be no decrease in stream pollution over the four-year period.

v. Six Mile Creek

The four stream samples taken on May 13, 1964, for the OWRC show no pollution and meet the water quality objectives, as indicated on table A19-26.

Not all of the water samples taken between Oct. 1965 and Dec. 1969 at the Lakeshore Road (stream mileage S 0.4) meet the objectives – see Table A19-27.

BOD concentrations up to 34 mg/l and DO concentrations as low as 4.0 mg/l were recorded. The maximum coliform counts were 640,000/100 ml. DO samples up to 170 per cent supersaturations (15 mg/l at 22 degrees C.) were recorded.

The stream pollution seems to be caused by inadequate and defective septic tank and tile bed systems, livestock operations and agricultural runoff.

vi. *Eight Mile Creek*

Seven stream samples taken in April and May 1964 show pollution in the vicinity of the Avondale Dairy Ltd. irrigation area — see Table A19-28.

The samples taken at the Lakeshore Road from Oct. 1965 to Dec. 1969 show signs of pollution — see Table A19-29. BOD concentrations as high as 20 mg/l and DO concentrations as low as 2 mg/l were recorded. The maximum coliform count was 142,000/100 ml. DO samples up to 145 per cent supersaturation (13 mg/l at 21 degrees C.) were observed.

The stream pollution, most likely, was caused by industrial (dairy) wastes, inadequate and defective septic tank and tile bed systems, livestock operations and agricultural runoff.

vii. *Welland Ship Canal*

The total average flow entering the Welland Ship Canal at Port Colborne is about 7,800 c.f.s. Of this volume about 1,000 c.f.s. are required to operate the canal during the navigation season. The balance is utilized by the HEPC De Cew power plants, industries and municipalities along the canal.

The samples taken at the 10 different stations along the canal from 1960 to 1963 as shown on Table A19-30 indicate that the canal is fairly well protected from sources of pollution. The BOD concentrations have been below the objective of 4 mg/l. The maximum coliform density of 114,000 organisms/100 ml was recorded at the Main Street Bridge in Port Colborne.

At the Lakeshore Road, St. Catharines (SC 2.0), below the weir, samples were taken from Oct. 1965 to Dec. 1970. BOD concentrations up to 7.0 mg/l have been recorded during the winter months. The maximum coliform density was 380,000 organisms/100 ml. The turbidities and the iron concentrations progressively increase as the water flows from Lake Erie towards Lake Ontario (see Table A19-31).

viii. *Twelve Mile Creek*

Most of the water originates from the Welland Ship Canal. Water for the power plants at De Cew Falls is diverted from the canal to the forebay, Lake Gibson, at a point near Allanburg. The outflow from Lake Gibson to Twelve Mile Creek is regulated at the power plants. According to the existing agreement with the St. Lawrence Seaway Authority, up to 6,430 c.f.s. can be used by the HEPC De Cew power plants.

The flumes of the new and old power plant discharge at the stream mileages T 6.87 and T 6.98, respectively, into Twelve Mile Creek.

In spite of this high and relatively constant flow, Twelve Mile Creek is polluted below mileage T 4.3, the confluence with the Second Welland Canal (Industrial Wastes Drain), which discharges about 67 c.f.s. of highly polluted waste into Twelve Mile Creek.

Even the maximum flow of 6,430 c.f.s from the power plants is not sufficient to obtain at times the water quality objective of 4.0 mg/l BOD in Twelve Mile Creek below the confluence with the Second Welland Canal. The OWRC Water Quality Samples taken on Nov. 16, 1970, show the following results:

Location	Time	BOD (mg/l)	Assumed Flow (c.f.s.)
1. Glendale Ave. (T 5.4)	17:40	2.0	6,430
2. Second Welland Canal (T 4.4) at Glenridge Ave.	18:00	240.0	67
3. Welland Vale Road (T 3.4)	17:20	4.5	6,497

Based on the assumed flows, the theoretic BOD value downstream of the confluence with the Second Welland Canal would have been 4.45 mg/l.

The results of the water quality samples taken from Twelve Mile Creek and its tributaries are shown on Tables A19-32 and A19-33.

Table A19-34 shows the water qualities at Lakeport Road (T 0.8) from Oct. 1965 to Dec. 1969. During this period BOD concentrations up to 8.5 mg/l and DO concentrations as low as 4.2 mg/l have been recorded. The maximum recorded coliform density was 410,000 organisms/100 ml.

The 1970 water qualities are shown on Table A19-35. Martindale Pond on Twelve Mile Creek acts as a big settling tank for the mostly organic suspended solids discharged from the Second Welland Canal. Concentrations up to 290 mg/l were recorded in 1970.

The water quality of the creek has not improved since 1965, due to the untreated or only partly treated industrial wastes discharged into the Second Welland Canal. Table A19-7 shows the other industries discharging directly into Twelve Mile Creek.

According to the water samples listed in the OWRC Water Resources Survey of the County of Welland (1964) only the water sample of Oct. 5/61 at TES 13.6, the South Branch of the Effingham Branch, had an excessive BOD-value. The very high BOD of 790 mg/l BOD may have been caused by the effluent of a cannery. Most of the sampling points shown on Table 19-33 show excessive coliform densities up to 59,000 organisms per 100 ml. The pollution upstream of the Second Welland Canal originates from inadequate and defective septic tank and tile bed systems as well as from livestock operations and agricultural runoff.

ix. Gibson Lake

The water diverted from the Welland Ship Canal at Allanburg for power generation at the De Cew power plants forms Gibson Lake upstream from the HEPC generation stations. Beaver Dams Creek is also discharging into the lake.

The water qualities of the lake are shown on Table A19-36. The lake has been polluted by Beaver Dams Creek. In the bay with the Beaver Dams Creek discharge, BOD concentrations up to 13.0 mg/l have been recorded. Much of the sediments, particularly, in Beaver Dams Bay are organic matter from the Beaver Wood Fibre Co. Ltd. The estimated quantity of sediments in the easterly part of Gibson Lake is about 625,000 cu. yds. or 400 ac. ft. Excessive coliform counts have been also recorded in the lake.

x. Beaver Dams Creek

Beaver Dams Creek is tributary to Gibson Lake by means of a siphon under the Welland Ship Canal and a pumping station at Gibson Lake, operated by the HEPC.

The wastes of the Beaver Wood Fibre Co. Ltd. with high BOD and suspended solid concentrations are discharged to Beaver Dams Creek. The wastewater from the Hayes-Dana Ltd., Drive-Drain Division and Frame Division, are also discharged to the creek, as listed on Table A19-6.

According to information received from the OWRC the present population equivalent of the wastes from the Beaver Wood Fibre Co. Ltd. are about 50,000 based on BOD and about 120,000 based on suspended solids. About 24,000 lbs. of suspended solids are daily discharged into Beaver Dams Creek and, consequently, into Gibson Lake.

The sanitary sewage from these industries is also discharged into the creek together with the septic tank overflows from houses at the upper and lower Windle Village and dwellings adjacent to the Beaver Wood Fibre Co. Ltd.

BOD concentrations up to 84 mg/l and suspended solids up to 80 mg/l were measured in the creek. The maximum coliform density was 740,000 organisms per 100 ml. (Table A19-36).

Beaver Dams Creek can be considered an open sewer.



Debris filled channel of Twenty Mile Creek near the hamlet of Fulton. Cleaning the channel would improve water quality and increase channel capacity during spring runoff.

LAKE ONTARIO

OLD WELLAND CANAL

MARTINDALE POND

ECKMAN DREDGE SAMPLING STATIONS

ON

MARTINDALE POND AND
TWELVE MILE CREEK

(1970)

LEGEND

SAMPLING STATIONS-----●-----3

SCALE 1320 660 330 0 1320 FEET

CITY

OF

ST

TWELVE MILE CREEK
CATHERINES



HWY No 8

FIG. 19-A1

xi. Second Welland Canal (Industrial Wastes Drain)

The Second Welland Canal discharges into Twelve Mile Creek. The canal is severely polluted. Table A19-37 shows that it contains highly coloured, malodorous and putrescible wastes, high in BOD, suspended solids and coliform density which eventually pollute Twelve Mile Creek. The same conditions still exist. For 1970, Table A19-35 shows for the Second Welland Canal, BOD loadings up to 300 mg/l, suspended solids up to 290 mg/l and dissolved oxygen concentrations as low as zero. The maximum coliform density was 660,000 organisms per 100 ml.

The OWRC survey of 1964 also states that the canal represents the greatest concentration of pollution within Welland County and that the waste in the canal is about equal to that produced by a population of 600,000.

The present equivalent is about 1,300,000 persons considering the BOD loading and about 450,000 persons based on the suspended solids loading as shown on Table A19-5.

Bacteriological samples in the canal showed coliform counts up to 10,000,000/100 ml.

According to Table A19-5, the six pulp and paper mills discharge about 36 m.g.d. of process wastes into the canal with a BOD loading of 223,000 lbs/day (625 mg/l) and a suspended solids loading of 91,300 lbs/day (256 mg/l). Forty-five tons of suspended solids are discharged daily into the canal. This is about 11,000 tons per year considering 250 working days. Consequently, this amount is discharged into Twelve Mile Creek and to a large extent will settle out in the Martindale Pond. The Federal Department of Public Works dredged Martindale Pond between 1965 and 1967 at a total cost of \$505,150. The department removed 244,133 cu. yds. of mostly organic material at an expenditure of \$266,650. Dike construction and other associated work added another \$238,500 to the contract cost.

In addition, the City of St. Catharines discharges the sewage from the former Town of Merriton (population 2,250) untreated into the canal.

xii. Fifteen Mile Creek

Samples taken from Oct. 1965 to Dec. 1969 at the Fourth Ave. (V 2.3) show that, at times, the creek is polluted. Table A19-38 shows BOD concentrations up to 9.2 mg/l and dissolved oxygen as low as 4.5 mg/l. The maximum recorded coliform density was 65,000 organisms/100 ml.

The water samples taken in Sept. 1961 at the stream mileages V 8.7, 9.5 and 12.3 meet the water quality objectives (Table A19-39).

The pollution at Fourth Ave. seems to be caused by inadequate and defective septic tank and tile bed systems, livestock operations and agricultural runoff.

xiii. Sixteen Mile Creek

Samples were taken from Oct. 1965 to Dec. 1969 at the Fourth Ave. (S 2.0) see Table A19-40. At times the stream had BOD concentrations up to 11.0 mg/l. The minimum dissolved oxygen concentrations were 5.0 mg/l and the maximum coliform density was 30,000 organisms/100 ml. Water samples taken in Aug. 1960 and Sept. 1961 at the stream mileages S 5.2 and 8.8 meet the water quality objectives.

The pollution at Fourth Ave. seems to be caused by inadequate and defective septic tank and tile bed systems, livestock operations and agricultural runoff (Table A19-39).

xiv. Twenty Mile Creek

Samples were taken from Oct. 1965 to Dec. 1970 at the 21st Street (J 2.4) and the results are shown on Table A19-41. The stream had BOD concentrations up to 13.0 mg/l. The minimum dissolved oxygen level was 4.0 mg/l and the maximum coliform density was 81,000 organisms/100 ml.

Dissolved oxygen samples taken in the daytime show up to 145 per cent supersaturation (13mg/l at 21 degrees C.) indicating excessive algae growths. Therefore DO levels at

night-time may be well below the objective of not less than 5 mg/l due to respiration.

Nutrients are also very high.

The stream pollution seems to be caused by inadequate and defective septic tank and tile bed systems, livestock operations and agricultural runoff.

xv. Thirty Mile Creek

Samples were taken from Oct. 1965 to Dec. 1970 at the Queen Elizabeth Highway (T 0.5) and the results are shown on Table A19-42.

BOD concentrations up to 13.0 mg/l were recorded. The minimum DO level was 5.0 mg/l and the maximum coliform density was 2,300,000 organisms/100 ml. Dissolved oxygen samples taken in the daytime show up to 175 per cent supersaturation (16 mg/l at 20 degrees C.) indicating excessive algae growths. Therefore, due to respiration at night-time DO levels may be well below the objective of not less than 5 mg/l.

Nutrients are also very high.

Stream pollution seems to be caused by inadequate and defective septic tank and tile bed systems, livestock operations and agricultural runoff.

xvi. Forty Mile Creek

Samples were taken from Oct. 1965 to Dec. 1970 downstream from the Town of Grimsby (FO 0.3) and the results are shown on Table A19-43.

The stream is severely polluted. BOD concentrations up to 500 mg/l and DO levels as low as 0.5 mg/l have been recorded as well as coliform densities up to 97,000,000/100 ml. The nutrients are also extremely high with total phosphorus up to 43.0 mg/l and NH_3 as N up to 28.0 mg/l.

The pollution is mainly caused by the inadequate operation of the Grimsby WPCP. As at other streams, inadequate and defective septic tank and tile bed systems, livestock operations and agricultural runoff may also contribute to the severe pollution. Except for the spring runoff and after heavy rainfalls Forty Mile Creek below Grimsby is an open sewer.

b. Streams discharging into Niagara River

i. Welland River

The Welland River and most of its tributaries are polluted, and exceed the water quality objectives. The Welland River upstream from the City of Welland showed BOD concentrations and coliform counts well above the water quality objectives of 4 mg/l and 2,400 coliform counts per 100 ml, respectively, during the five-year period from 1959 to 1964. The same or worse conditions can be anticipated today since no major water pollution control measures have been undertaken.

At the crossing of the Welland Canal and the Welland River in the City of Welland, canal water is diverted to the river. This dilution water avoids severe deterioration of the water quality in the river in spite the Welland WPCP which has been operating since 1968. The plant is located at stream mileage PW 17.3. Prior to 1968, no treatment was provided.

The additional flow from the canal even prior to the primary WPCP improved the water qualities of the river so that the average BOD of five samples at the former Pelham Township — Welland Line (PW 21.2) — upstream of Welland was 5.9 mg/l compared to 2.6 mg/l below Welland at the Port Robinson Bridge (PW 14.6) (see Table A19-44). Actually, the Welland WPCP has not improved the water quality of the Welland River. Water quality samples taken at the Port Robinson Bridge from Oct. 1965 to Dec. 1969 show that the average BOD increased from 2.7 p.p.m. in 1966 to 2.9 p.p.m. in 1969. Also, the median coliform counts per 100 ml. increased during this period from 3,110 to 15,000 (see Table A19-45).

The reasons for these conditions are:

1. not all the municipal sewers are connected to the Welland WPCP.

2. the primary treatment process provides only 35 per cent BOD removal and
3. the wastes of Atlas Steels Limited are discharged untreated to the Welland River.

The City of Welland has a population of about 40,000 and therefore with 35 per cent BOD removal, the BOD of a population equivalent of 26,000 is still discharged into the Welland River.

According to OWRC information, the Atlas Steels Limited discharges 7.5 m.g.d. of process wastes with a BOD loading of 5,000 lbs/day into the river which is equivalent to a BOD of 67 mg/l and a population equivalent of about 29,000.

Based on these considerations the present BOD loading on the river will be equivalent to a population of about 55,000, or the Welland WPCP provides an over-all BOD reduction of only 20 per cent. Even the proposed secondary treatment process for the Welland WPCP will reduce the over-all BOD load by only 52 per cent. Therefore, the water quality objective in the river can be only obtained if Atlas Steels Ltd. provides extensive waste treatment with maximum concentration not exceeding 15 mg/l BOD and iron removal so that it will be less than 1.6 mg/l in the river, all as outlined in the guideline tables. The OWRC considers the present treatment conditions as unsatisfactory. Below Port Robinson, the Welland Plant of the Cyanamid of Canada Ltd. discharges daily 10,000 to 20,000 lbs. of suspended solids, 20,000 to 30,000 lbs. of nitrogen compounds, 4,000 lbs. of ammonia compounds and 20 lbs. of cyanide into the Welland River and its tributary, Thompsons Creek. All these loads exceed the recommended maximum concentrations in the effluent. The OWRC considers the present conditions as unsatisfactory.

In 1969 the average and maximum concentrations in nitrogen and ammonia compounds between Port Robinson (PW 14.6) and Montrose Bridge (PW 9.2) were as follows: (See Table A19-45 and A19-46)

	AVERAGE			MAXIMUM		
	NH ₃ as N (mg/l)	Total Kjeldahl (mg/l)	NO ₃ as N (mg/l)	NH ₃ as N (mg/l)	Total Kjeldahl (mg/l)	NO ₃ as N (mg/l)
Port Robinson (PW 14.6)	0.48	1.27	0.04	1.60	2.80	2.00
Montrose Bridge (PW 9.2)	7.67	14.20	3.37	26.00	63.00	20.00

Insufficiently treated process waste water in smaller quantities is also discharged into the river by the plants of B.F. Goodrich Canada Ltd. and the Ford Motor Co. of Canada Ltd.

The industrial wastes of the Norton Company are discharged in the East Welland River which normally flows from the Niagara River to the HEPC Power Canal. The company is discharging about 8,000 lbs/day of suspended solids. The OWRC considers the present condition as unsatisfactory. (See Tables A19-47, A19-48 and A19-49)

The following tributaries of the Welland River were also surveyed:

1. Lyons Creek

Lyons Creek at mileage point PWEL 23.2, immediately downstream from the City of Welland, Bradley Street pumping station, is grossly polluted. The Welland Tubes Works also discharge insufficiently treated waste waters into the creek. These sources of pollution will be kept out of the creek after the Welland Canal has been relocated, as this part of the drainage basin, west of the new ship canal, will discharge directly into the canal. This change should improve the water quality in the remaining part of the Lyons Creek. (See Table A19-50.)

2. Thompsons Creek

Thompsons Creek below the Cyanamid of Canada Ltd. plant is severely polluted.

3. Coyle Creek
Coyle Creek, upstream of the City of Welland, shows excessive coliform counts. This pollution may be caused by rural developments and agricultural drainage.
4. Disused Feeder Canal
The water quality of the disused feeder canal is questionable and shows excessive BOD concentrations.
5. Forks Creek
Forks Creek and its branches are at times heavily polluted due to rural and livestock operations.
6. Oswego Creek
Excessive BOD concentrations exist also at Oswego Creek.

ii. Usshers Creek

Samples taken from Oct. 1965 to Dec. 1969 at the Niagara Parkway (U 0.0) show that at times the creek is polluted. Table A19-51 shows BOD concentration up to 9.0 mg/l and dissolved oxygen concentration as low as 0.2 mg/l. The maximum recorded coliform density was 57,000 organisms/100 ml.

The water samples taken in May, 1961, at the stream mileage U 1.2 and U 2.9 show excessive BOD concentration as indicated on Table A19-52. However, the coliform counts meet the objective.

The pollution at the Niagara Parkway seems to be caused by inadequate and defective septic tank and tile bed systems.

iii. Bayers Creek

Samples were taken at two sampling points in July, 1959, and May, 1961. One sample, as shown on Table A19-52 showed an excessive BOD concentration of 6 mg/l.

iv. Black Creek

Samples taken from Oct. 1965 to Dec. 1969 at the Niagara Parkway (B 0.1) show that at times the creek is polluted. Table A19-53 shows BOD concentration up to 4.6 mg/l and dissolved oxygen concentration as low as 4.0 mg/l. The maximum recorded coliform density was 360,000 organisms per 100 ml.

In the period of July, 1959, to March, 1963, water samples were taken at 21 sampling points along Black Creek and its tributaries — in particular, Beaver Creek. At all sampling points the water quality objectives were exceeded with respect to BOD concentration and coliform counts. (See Table A19-54.)

The waters of Black Creek are highly coloured with Hazen unit readings up to 260. Sewers in Stevensville discharge wastes up to 580 mg/l BOD in Black Creek and the maximum coliform density recorded was 84,000,000/100 ml.

Overflows from inadequate and defective septic tank and tile bed systems pollute the creek severely at Stevensville.

The excessive BOD concentration upstream of Stevensville (BL 5.5) originates presumably from decaying organic material in the headwaters of Black Creek, the Humberstone Marsh, as the coliform densities are well below the objective.

v. Baker Creek

Samples taken from Oct. 1965 to Dec. 1969 at the Niagara Parkway (BK 0.1) showed, at times, excessive BOD concentrations up to 5.6 mg/l and DO concentrations as low as 0.6 mg/l. The maximum recorded coliform density was 25,000 organisms /100 ml, all as shown on Table A19-55. Additional samples are shown on Table A19-56.

The pollution seems to be caused by inadequate and defective septic tank and tile bed systems.

vi. *Miller Creek*

Samples taken from Oct. 1965 to Dec. 1969 at the Niagara Parkway (M 0.1) show, at times, excessive BOD concentrations up to 8.0 mg/l, and DO concentrations as low as 4.8 mg/l. The maximum recorded coliform density was 630,000 organisms /100 ml, all as shown on Table A19-57. Additional samples are shown on Table A19-56. The pollution seems to be caused by inadequate and defective septic tank and tile bed systems.

vii. *Frenchman Creek*

Samples taken from Oct. 1965 to Dec. 1969 at the Niagara Parkway (FR 0.0) show, at times, excessive BOD concentrations up to 10.0 mg/l and DO concentrations as low as 1.0 mg/l. The maximum recorded coliform density was 109,000 organisms /100 ml, all as shown on Table A19-58. Additional samples are shown on Table A19-56.

The pollution seems to be caused by inadequate and defective septic tank and tile bed systems.

c. *Water courses discharging into Lake Erie*

Small portions of the Town of Fort Erie, City of Port Colborne and the Townships of Wainfleet, Moulton and Sherbrooke drain into Lake Erie.

In the Town of Fort Erie the portion draining to Lake Erie has a permanent population of 6,000 and an estimated summer population in excess of 13,000. The total flow from the main outlets to Lake Erie, during dry weather, is about 0.5 m.g.d. (0.9 c.f.s.). The water along the shoreline, in the vicinity of these outfalls, is covered with abundant algae and in certain areas the odour of decaying algae mixed with sewage is strong during the summer months.

Table A19-59 shows the water quality of samples taken by the OWRC and the Niagara District Health Unit. BOD concentration up to 504 mg/l and coliform densities up to 210,000,000 /100 ml, have been recorded in the Town of Fort Erie. Concentrations up to 42.0 mg/l of ABS anionic detergents were also recorded.

In the City of Port Colborne the maximum BOD concentration was 74.0 mg/l with a coliform density of 90,000 organisms /100 ml.

In the Township of Wainfleet, the Long Beach area storm sewer had a BOD of 14 mg/l and a coliform density of 1,000,000 organisms /100 ml.

In Port Colborne, the International Nickel Co. of Canada Ltd. discharges 8 m.g.d. (14.8 c.f.s.) of process waste water into Lake Erie. These waste waters contain 4,000 lbs/day suspended solids, which is equivalent to a population of 20,000. These discharges include 480 lbs/day of nickel and 200 lbs/day of copper. According to the OWRC the existing conditions are unsatisfactory.

The Algoma Steel Corp. Ltd. (Canadian Furnace Division) discharges about 16 m.g.d. (29.6 c.f.s.) into the Lake Erie. However, the treatment is satisfactory.

Table A19-17: Water Quality of One Mile Creek Stream Mileage — 0.01 Niagara Boulevard

	Coli- forms MF/100ml	Water Temp. °C	DO (mg/l)	BOD ₅ [*] (mg/l)	Tot. solids (mg/l)	Susp. solids (mg/l)	Turb- idity (units)	Cond. 25°C (umhos/cm ³)	Tot. P as P	Sol. P as P	NH ₃ N KJEL +	Tot. N KJEL +	NO ₂ N (mg/l)	NO ₃ N (mg/l)	Chlor- ide (mg/l)	Hard- nes (mg/l)	Alk. CaCO ₃ (mg/l)	Tot. Iron (mg/l)	Phenols (ppb)	
1. W.Y. 1965/66	9	9	9	9	8	9	8	7	9	8	9	9	9	9	7	3	4	3	4	
No. of Samples	1,870,000	30.0	12.3	18.0	562	103	31	786	8.15	7.17	18.00	23.10	0.77	1.50	62	370	275	3.50	8.1	
Maximum	420	0.0	0.5	0.2	422	15	3.1	562	0.15	0.14	0.00	0.33	0.00	0.00	29	190	218	0.29	7.4	
Minimum	Average	14.6	6.8	5.0	494	39	16.0	692	2.42	2.25	4.04	4.66	0.10	0.31	44	303	253	1.44	7.9	
Median	21,600																			
2. W.Y. 1966/67	12	13	13	13	13	13	13	13	12	12	12	11	12	12	12	9	8	9	9	
No. of Samples	64,000	25.0	13.0	8.4	554	74	36	898	2.45	1.26	1.18	5.90	0.13	1.75	47	370	315	1.75	8.9	
Maximum	100	0.0	0.5	1.4	250	3	4	497	0.01	0.01	0.03	0.65	0.00	0.00	31	216	188	0.27	7.3	
Minimum	Average	13.1	6.3	3.4	448	23	15	657.6	0.57	0.28	0.44	1.73	0.03	0.35	36.7	297	224	0.73	8.1	
Median	3,950																			
3. W.Y. 1967/Dec.68	18	18	18	18	18	18	15	18	18	17	18	17	17	17	18	8	8	8	8	
No. of Samples	43,000	26.0	11.5	13.0	620	90	31	968		0.85	1.81	1.81	0.05	5.90	46	410	338	4.30	8.0	
Maximum	128	0.0	0.6	0.6	300	5	4	490		0.10	0.30	0.00	0.00	0.02	26	198	138	0.47	7.5	
Minimum	Average	14.1	5.8	3.1	491	31	17.4	694		0.38	1.18	1.18	0.02	0.80	35	287	240	1.89	7.8	
Median	2,100																			
4. 1969	12	14	14	14	14	14	14	14	14	13	13	14	14	13	11	5	4	4	4	
No. of Samples	63,000	25.0	13.0	4.0	570	130	56	791	1.80	1.30	0.94	1.90	0.05	1.70	41	414	292	4.00	8.1	
Maximum	2,000	0.0	1.2	1.6	300	5	6	482	0.16	0.03	0.08	0.53	0.00	0.01	25	200	150	0.70	7.3	
Minimum	Average	12.6	7.9	2.6	455	30	16.6	658	0.46	0.24	0.36	1.11	0.01	0.43	33	320	228	2.25	7.8	
Median	5,350																			

* BOD₅ — 5-day biochemical oxygen demand
+ KJEL — Kjeldahl nitrogen test

Table A19-18: Water Quality of Two Mile Creek Stream Mileage -- T 0.1 Lakeshore Road

	Coli- forms MF/100ml	Water Temp. °C	DO (mg/l)	BOD ₅ * (mg/l)	Tot. Solids (mg/l)	Turb- idity (units)	Cond 25°C (umhos/cm ³)	Tot. P as P (mg/l)	Sol. P as P (mg/l)	NH ₃ as N (mg/l)	Tot. KJEL ⁺ (mg/l)	NO ₂ N (mg/l)	NO ₃ N (mg/l)	Chlor- ide (mg/l)	Hard- ness (mg/l)	Alk. CaCO ₃ (mg/l)	Tot. Iron (mg/l)	Phenols (ppb)
1. W.Y. 1965/66																		
No. of Samples	7	7	7	7	7	6	5	7	6	7	6	7	7	5	3	4	3	4
Maximum	4,500	22.0	11.0	4.6	692	60	937	0.48	0.33	0.39	1.60	0.03	5.00	71	420	190	2.20	8.4
Minimum	260	0.0	7.0	1.2	480	5	23	0.03	0.00	0.00	0.52	0.00	0.00	41	220	128	0.61	7.9
Average		12.0	9.1	2.3	623	26	646	0.17	0.10	0.10	0.93	0.01	1.53	59	343	157	1.15	8.1
Median	690																	
2. W.Y. 1966/67																		
No. of Samples	14	15	15	15	14	15	15	14	14	14	14	14	14	14	11	10	11	6
Maximum	149,000	23.5	13.0	3.4	1344	324	1387	0.26	0.25	0.33	1.80	0.08	8.75	134	614	251	13.00	8.6
Minimum	84	0.0	5.0	0.4	415	1	344	0.02	0.00	0.02	0.39	0.00	0.02	46	386	104	0.02	7.8
Average		10.3	9.0	1.6	780	35	978.5	0.08	0.05	0.14	0.87	0.02	1.94	73.9	467	152	1.69	8.2
Median	1,695																	
3. W.Y. 1967/Dec. 68																		
No. of Samples	18	18	18	18	18	18	18	18	18	18	18	18	18	18	8	8	8	8
Maximum	27,000	23.0	13.0	4.2	986	94	1276	0.20	0.15	0.59	1.40	0.08	5.00	83	660	308	0.85	8.2
Minimum	48	0.0	7.0	0.3	474	2	666	0.02	0.00	0.02	0.40	0.00	0.00	4	288	147	0.11	7.7
Average		11.2	9.7	1.4	709	20	968	0.18	0.05	0.18	0.78	0.02	1.35	60	465	188	0.38	8.0
Median	3,000																	
4. 1969																		
No. of Samples	11	13	13	13	13	13	13	13	12	12	13	13	11	11	4	3	3	3
Maximum	12,000	23.0	13.0	3.0	880	40	1120	0.20	0.15	0.56	1.00	0.07	3.10	88	624	272	0.95	8.3
Minimum	168	0.0	3.8	0.6	360	5	559	0.02	0.01	0.02	0.37	0.00	0.01	28	399	131	0.15	8.1
Average		10.1	9.4	1.8	635	11	894	0.08	0.05	0.15	0.70	0.02	1.14	25	483	185	0.45	8.2
Median	1,800																	

* BOD₅ -- 5-day biochemical oxygen demand
+ KJEL -- Kjeldahl nitrogen test

Table A19-19: Two Mile Creek

Sampling Point No.	Location	Date	BOD ₅ (ppm)	Solids (ppm)			Coliform Count per 100 ml.
				Total	Susp.	Diss.	
T 1.0	Lakeshore Road	June 2/64	1.4	570	2	568	2,600
T 1.7	Niagara Stone Road	June 2/64	1.3	542	1	541	600
T 3.4	Plum Street	June 2/64	1.0	740	1	739	42

Table A19-20: Three Mile Creek

Sampling Point No.	Location	Date	BOD ₅ (ppm)	Solids (ppm)			Coliform Count per 100 ml.
				Total	Susp.	Diss.	
TH 0.3	Lakeshore Road	June 2/64	1.8	592	3	589	138
TH 1.4	Hunter Road	June 2/64	6.2	804	90	714	540

Table A19-21: Four Mile Creek

Sampling Point No.	Location	Date	BOD ₅ (ppm)	Solids (ppm)			Coliform Count per 100 ml.
				Total	Susp.	Diss.	
F 0.5	Lakeshore Road	June 2/64	1.1	538	4	534	1,100
FW 2.5	West Branch of east and west line	June 2/64	1.7	444	3	441	1,400
F 2.4	At east and west road	June 2/64	1.8	600	10	590	2,700
FS 3.2	South branch at Conc. road 6	June 2/64	1.4	574	7	567	224
F 3.2	Line 1	June 2/64	2.5	838	42	796	6,500
F 4.6	Line 3	June 2/64	19.0	822	8	814	3,100
F 7.0	Line 7	May 15/64	2.8	654	14	640	12,000
FSW 7.8	South west branch 1/4 mile above junction	May 15/64	18.0	1,506	37	1,469	1,400
FD 8.2	St. Davids branch just above junction	May 15/64	1.4	1,498	7	1,491	180
FD 8.7	St. Davids Branch	June 2/64	13.4	786	24	762	670,000
F 8.2	Line 9	May 15/64	2.0	572	10	562	22,000
F 9.5	Townline road, one mile south of St. Davids	May 15/64	0.9	568	11	557	730

Table A19-22: Water Quality of Four Mile Creek Stream Mileage – F 0.5 Lakeshore Road

	Coli- forms MF/100ml	Water Temp. °C	DO (mg/l)	BOD ₅ * (mg/l)	Tot. Solids (mg/l)	Susp. Solids (mg/l)	Turbidity (units)	Cond 25°C (umhos/cm ³)	Tot. P as P (mg/l)	Sol. P as P (mg/l)	NH ₃ as N (mg/l)	Tot. N KJEL ⁺ (mg/l)	NO ₂ as N (mg/l)	NO ₃ as N (mg/l)	Chloride (mg/l)	Hardness (mg/l)	Alk. CaCO ₃ (mg/l)	Tot. Iron (mg/l)	Phenols (ppb)
1. W.Y. 1966/66																			
No. of Samples	9	9	9	8	9	7	7	6	9	9	9	8	9	9	8	3	4	3	4
Maximum	34,000	25.0	11.5	3.6	756	50	43.0	1070	0.24	0.16	0.38	1.65	0.15	2.60	107	420	226	3.00	8.3
Minimum	80	0.4	6.0	1.2	480	15	8.0	671	0.06	0.04	0.02	0.84	0.00	0.00	45	290	149	0.49	7.9
Average		14.8	8.5	2.5	632	25	18.2	847	0.14	0.08	0.15	1.23	0.03	0.67	78	353	190	2.02	8.1
Median	510																		
2. W.Y. 1966/67																			
No. of Samples	15	16	16	15	16	16	16	16	15	15	15	15	15	15	14	6	10	11	11
Maximum	26,000	24.5	13.0	110.0	984	112	87	1360	0.26	0.16	0.36	1.82	1.00	4.00	145	410	257	3.18	8.70
Minimum	80	0.0	3.0	0.5	510	4	4	713	0.00	0.00	0.03	0.58	0.00	0.00	48	310	146	0.12	7.70
Average		11.0	8.6	8.9	699	30	27.7	949.5	0.12	0.08	0.19	1.16	0.09	1.86	86.5	341	200	0.97	8.14
Median	1,540																		
3. W.Y. 1967/Dec. 68																			
No. of Samples	18	18	18	18	18	18	17	18			18	18	18	18	18	8	8	8	8
Maximum	14,000	24.0	16.0	9.0	996	108	91	1400			1.10	2.20	0.14	36.00	133	476	253	2.05	
Minimum	56	0.0	6.5	0.6	430	4	4.5	558			0.02	0.58	0.00	0.00	33	256	159	0.39	
Average		11.5	9.6	3.2	642	26	24.5	891			0.29	1.23	0.03	3.13	76	381	209	1.22	
Median	945																		
4. 1969																			
No. of Samples	12	14	14	14	14	14	14	14	14	14	14	14	14	12	12	5	5	4	5
Maximum	7,000	23.0	12.0	7.0	770	250	400	1071	1.10	0.21	0.70	7.50	0.12	2.20	114	428	250	1.30	8.3
Minimum	90	0.0	5.5	1.0	380	5	4	469	0.10	0.01	0.01	0.98	0.00	0.01	23	302	99	0.45	7.8
Average		11.2	8.1	3.8	552	42	55.1	789	0.26	0.09	0.24	1.74	0.04	1.00	63	358	199	0.84	8.1
Median	1,850																		

* BOD₅ – 5-day biochemical oxygen demand
+ KJEL – Kjeldahl nitrogen test

Table A19-23: Water Quality of Four Mile Creek Stream Mileage — F 4.6 Third Line Road

	Coli- forms MF/100ml	Water Temp. °C	DO (mg/l)	BOD ₅ * (mg/l)	Tot. Solids (mg/l)	Susp. Solids (mg/l)	Turb- idity (units)	Cond. 25°C. (umhos/cm ³)	Tot. P as P (mg/l)	Sol. P as P (mg/l)	NH ₃ as N (mg/l)	Tot. KJEL+ N (mg/l)	NO ₂ N (mg/l)	NO ₃ as N (mg/l)	Chlor- ide (mg/l)	Hard- ness (mg/l)	Alk. CaCO ₃ (mg/l)	Tot. Iron (mg/l)	Phenols (ppb)	pH
1. W.Y. 1965/66																				
No. of Samples	9	9	9	9	9	9	8		7	9	9	9	9	9	8	3	4	3	4	
Maximum	64,000	24.0	11.0	9.2	816	72	45	1061	0.46	0.26	0.60	1.80	0.30	1.20	127	440	316	2.80	8.2	
Minimum	124	0.0	5.5	1.2	566	22	6.5	720	0.03	0.00	0.00	0.26	0.00	0.00	60	320	174	0.48	7.8	
Average		14.5	8.2	3.7	724	43	25.3	989	0.22	0.10	0.21	1.24	0.06	0.28	97	386	213	1.73	8.0	
Median	5,700																			
2. W.Y. 1966/67																				
No. of Sample	10	11	11	11	11	11	11	11	10	10	10	10	10	10	11	4	8	8	8	
Maximum	80,000	26.0	10.0	67.0	970	204	100.0	1251	0.26	0.10	1.64	2.08	0.06	4.00	132	430	282	8.00	8.4	
Minimum	320	0.0	5.0	0.6	576	22	11	804	0.02	0.00	0.06	0.65	0.00	0.02	69	336	179	0.80	7.6	
Average		10.3	7.9	8.4	778	69	43	1020	0.13	0.05	0.40	1.45	0.03	1.18	97	384	217	2.43	8.1	
Median	11,200																			
3. W.Y. 1967/Dec. 68																				
No. of Samples	18	18	18	18	18	18	18	18			18	18	18	18	18	8	8	8	8	
Maximum	70,000	27.0	14.0	13.0*	1010	222	105	1395			1.10	3.70	0.10	2.60	192	504	300	2.38	8.1	
Minimum	36	0.0	6.0	1.2	420	8	6	13			0.02	0.62	0.00	0.00	31	296	150	0.42	7.8	
Average		11.9	9.7	4.2	712	48	36	836			0.38	1.59	0.04	0.93	96	393	222	1.39	8.0	
Median	595																			
4. 1969																				
No. of Samples	12	14	14	14	14	14	14	14	14	14	14	14	14	12	12	5	4	4	4	
Maximum	2,900	25.0	14.0	11.0	850	180	400	1218	2.00	0.21	0.65	2.70	0.18	2.20	138	516	279	2.20	8.6	
Minimum	20	0.0	6.0	2.0	296	10	10	415	0.07	0.01	0.04	0.84	0.00	0.01	27	306	190	0.33	7.9	
Average		13.3	9.2	5.2	601	72	67	833	0.31	0.06	0.26	1.47	0.06	0.97	76	399	218	1.18	8.2	
Median	320																			

* BOD₅ — 5-day biochemical oxygen demand
+ KJEL — Kjeldahl nitrogen test

Table A19-24: Water Quality of Four Mile Creek Stream Mileage – F 7.0 Seventh Line Road

	Coli- forms MF/100ml	Water Temp. °C	DO (mg/l)	BOD ₅ (mg/l)	Tot. Solids (mg/l)	Susp. Solids (mg/l)	Turb- idity (units)	Cond. 25°C. (umhos/cm ³)	Tot. P asP (mg/l)	Sol. P asP (mg/l)	NH ₃ N (mg/l)	Tot. as KJEL ⁺ (mg/l)	NO ₂ N (mg/l)	NO ₃ N (mg/l)	Chlor- ide (mg/l)	Hard- ness (mg/l)	Alk. CaCO ₃ (mg/l)	Tot. Iron (mg/l)	Phenols pH (ppb)
1. W.Y. 1965/66																			
No. of Samples	8	9	9	10	9	8	7	16	8	9	9	8	9	9	8	3	8	3	7
Maximum	910,000	24.0	13.0	420	1198	76	32	1433	0.40	0.27	0.23	2.60	0.07	1.20	240	470	354	3.05	8.6
Minimum	510	0.3	4.5	0.4	862	15	1	800	0.07	0.02	0.00	0.78	0.00	0.00	69	410	193	0.50	7.0
Average		14.8	10.1	56.1	872	38	13.2	1159	0.19	0.13	0.07	1.35	0.02	0.40	115	446	251	1.92	8.0
Median	8,850																		
2. W.Y. 1966/67																			
No. of Samples	11	12	12	12	12	12	12	12	11	11	11	11	11	11	11	4	12	8	12
Maximum	520,000	28.0	12.5	132.0	1102	100	43	1457	0.55	0.14	0.43	2.80	0.10	1.75	153	450	295	2.70	8.7
Minimum	250	0.0	1.2	0.5	596	13	6.0	910	0.03	0.00	0.02	0.52	0.00	0.00	59	372	191	0.32	7.0
Average		10.6	8.0	16.8	814	36	22.8	1116	0.19	0.06	0.17	1.60	0.02	0.26	102	421	240	1.25	8.1
Median	63,000																		
3. W.Y. 1967/Dec. 68																			
No. of Samples	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	8	8	8	8
Maximum	550,000	35.0	60.0	9.0	1070	708	68.0	1298			0.59	2.20	0.14	2.60	152	552	298	1.84	8.6
Minimum	2,900	0.0	5.0	0.9	628	13	6.5	880			0.03	0.55	0.01	0.40	60	392	198	0.64	8.0
Average		12.8	12.8	3.2	829	70	27.9	1118			0.26	1.15	0.05	1.47	110	468	266	1.31	8.2
Median	8,700																		
4. 1969																			
No. of Samples	12	14	14	14	13	13	13	13	13	13	13	13	13	12	11	4	3	3	3
Maximum	6,600,000	24.0	12.0	12.0	1090	120	65	1594	0.86	0.40	0.45	3.80	0.13	3.20	253	500	299	3.30	8.7
Minimum	3,700	0.0	6.0	1.6	520	5	1.4	755	0.09	0.02	0.01	0.50	0.00	0.54	59	404	243	1.10	8.0
Average		12.5	9.3	3.6	760	46	31.4	1035	0.22	0.11	0.18	1.20	0.06	1.8	100	443	262	1.93	8.3
Median	59,100																		

* BOD₅ – 5-day biochemical oxygen demand
+ KJEL – Kjeldahl nitrogen test

Table A19-25: Water Quality of Four Mile Creek Stream Mileage – F 8.2 Downstream of St. Davids

	Coli- forms MF/100ml	Water Temp. °C	DO (mg/l)	BOD ₅ * (mg/l)	Tot. Solids (mg/l)	Susp. Solids (mg/l)	Turb- idity (units)	Cond. 25°C. (umhos/cm ³)	Tot. P asP (mg/l)	NH ₃ N (mg/l)	Tot. KJEL ⁺ (mg/l)	NO ₂ as N (mg/l)	NO ₃ N (mg/l)	Chlor- ide (mg/l)	Hard- ness (mg/l)	Alk. CaCO ₃ (mg/l)	Tot. Iron (mg/l)	Phenols (ppb)
1. W.Y. 1965/66																		
No. of Samples	9	9	9	9	9	9	8		6	8	8	9	9	7	3	6	3	7
Maximum	2,130,000	23.0	10.8	30.0	795	144	53	1100	0.59	0.31	0.83	2.50	0.20	94	450	278	1.38	8.5
Minimum	4,300	0.2	2.8	1.9	602	15	3.8	661	0.10	0.00	0.00	0.46	0.00	45	430	196	0.10	7.5
Average		15.0	7.8	7.0	695	48	24.5	912	0.27	0.12	1.27	0.04	0.66	67	443	248	0.66	8.0
Median	147,000																	
2. W.Y. 1966/67																		
No. of Samples	10	12	12	12	12	12	12	12	10	11	11	11	11	11	4	12	8	12
Maximum	1,370,000	23.5	12.0	81.0	810	63	36	1098	0.72	0.29	0.49	2.95	0.10	107	482	281	2.25	8.5
Minimum	7,000	0.0	5.0	1.1	638	3	6.3	913	0.03	0.02	0.02	0.52	0.00	52	400	239	0.32	7.3
Average		10.7	8.1	14.7	717	25	18.3	992	0.22	0.13	1.18	0.03	1.13	69	448	261	1.36	8.1
Median	111,000																	
3. W.Y. 1967/Dec. 68																		
No. of Samples	18	18	18	18	18	18	18	18		18	18	18	18	18	8	7	8	8
Maximum	11,000,000	25.0	14.0	7.9	1410	124	45	2252		0.07	1.80	0.61	3.20	528	580	289	2.37	8.4
Minimum	4,000	0.0	4.0	1.2	652	7	6.5	780		0.02	0.40	0.02	0.82	56	380	245	0.25	7.8
Average		11.3	8.7	2.7	760	27	18.2	1053		0.29	1.06	0.09	2.03	96	447	262	0.95	8.2
Median	33,000																	
4. 1969																		
No. of Samples	12	14	14	14	14	14	14	14	14	13	14	14	13	12	5	4	4	4
Maximum	11,000,000	22.5	14.0	13.0	950	290	80	1344	0.96	0.51	0.61	3.30	1.20	183	436	261	2.40	8.8
Minimum	7,500	0.0	4.0	1.0	620	5	10	855	0.15	0.02	0.04	0.28	0.03	50	391	253	1.85	7.9
Average		12.3	8.2	3.8	791	129	30.4	963	0.37	0.15	0.26	1.26	0.15	68	424	257	2.06	8.3
Median	65,000																	

* BOD₅ – 5-day biochemical oxygen demand
+ KJEL – Kjeldahl nitrogen test

Table A19-26: Six Mile Creek

Sampling Point	Location	Date	BOD ₅ (ppm)	Solids (ppm)		Coliform Count per 100 ml.
				Total	Diss.	
S 0.1	0.1 miles from Lake Ontario	May 13/64	2.8	994	6	988
S 0.8	Lakeshore Road	May 13/64	1.4	990	5	985
S 3.9	Niagara Stone Rd.	May 13/64	1.6	1,256	13	1,243
S 5.8	Highway 8	May 13/64	1.2	1,330	19	1,311

Table A19-27: Water Quality of Six Mile Creek Stream Mileage – S 0.4 Lakeshore Road

	Coli- forms MF/100ml	Water Temp. °C	DO (mg/l)	BOD ₅ * (mg/l)	Tot. Solids (mg/l)	Turb- idity (units)	Cond. 25°C, (umhos/cm ³)	Tot. P as P (mg/l)	Sol. P as P (mg/l)	NH ₃ N (mg/l)	Tot. KJEL ⁺ (mg/l)	NO ₂ as N (mg/l)	NH ₃ N (mg/l)	Chlor- ide (mg/l)	Hard- ness (mg/l)	Alk. CaCO ₃ (mg/l)	Tot. Iron (mg/l)	Phenols (ppb)	
																		pH	
1. W. Y. 1965/66																			
No. of Samples	9	9	9	9	8	7	6	9	9	9	8	9	8	7	3	4	3	4	
Maximum	114,000	23.0	15.0	34.0	1210	44	1550	0.98	0.66	8.20	16.00	0.40	1.00	287	490	246	1.85	9.0	
Minimum	420	0.2	4.0	1.1	576	5	797	0.07	0.05	0.06	0.78	0.00	0.00	54	310	116	0.42	8.0	
Average	14.9	10.1	5.7	850	21	12.8	1214	0.28	0.20	1.30	3.29	0.06	0.21	134	416	174	0.93	8.4	
Median	8,260																		
2. W. Y. 1966/67																			
No. of Samples	14	15	14	15	15	15	15	14	14	14	14	14	14	14	11	10	11	11	
Maximum	640,000	25.0	13.0	12.0	1826	120	2580	2.78	1.77	0.72	2.80	0.35	3.50	506	650	239	7.13	8.7	
Minimum	240	0.0	4.0	0.6	572	2	745	0.03	0.00	0.02	0.46	0.00	0.00	62	308	135	0.00	7.8	
Average	11.1	8.9	2.8	887	31	25.5	1232.5	0.32	0.20	0.24	1.21	0.05	1.06	153.9	406	195	1.54	8.2	
Median	4,300																		
3. W. Y. 1967/Dec. 68																			
No. of Samples	18	18	18	18	18	17	18	18	18	18	18	18	18	18	8	8	8	8	
Maximum	300,000	24.0	13.0	10.0	1506	263	1987	4.20	0.08	1.43	4.20	0.08	1.80	353	596	248	34.15	8.3	
Minimum	0	0.0	6.0	1.2	442	6	557	0.03	0.58	0.03	0.58	0.00	0.00	39	222	137	0.27	7.7	
Average	11.0	9.3	3.6	943	55	40.3	1303	0.55	1.58	0.55	1.58	0.03	0.57	176	427	204	1.61	8.0	
Median	1,335																		
4. 1969																			
No. of Samples	12	14	14	14	14	14	14	14	14	14	14	14	13	12	5	5	4	5	
Maximum	16,300	23.0	11.0	6.0	1400	100	2118	0.70	0.34	1.90	4.40	0.27	1.60	310	680	276	3.25	8.8	
Minimum	120	0.0	4.2	1.6	420	5	552	0.06	0.02	0.08	0.93	0.01	0.03	36	318	92	0.35	7.7	
Average	10.9	8.4	3.2	809	28	27.2	1161	0.24	0.11	0.69	1.79	0.05	0.46	145	470	203	1.49	8.2	
Median	2,050																		

* BOD₅ – 5-day biochemical oxygen demand
+ KJEL – Kjeldahl nitrogen test

Table A19-28: Eight Mile Creek

Sampling Point No.	Location	Date	BOD ₅ (ppm)	Solids (ppm)			Coliform Count per 100 ml.
				Total	Susp.	Diss.	
E 0.1	0.1 miles from Lake Ontario	May 13/64	2.6	300	7	293	870
E 1.2	Church Road	May 13/64	1.9	248	12	236	1,020
E 1.9	Scott Road	May 13/64	3.4	640	39	601	300
E 2.5	Carlton Road	May 13/64	1.8	1,018	9	1,009	90
EW 2.7	West branch, at Carlton Road	May 13/64	1.8	216	18	198	52,000
EWC 4.4	Carlton Road at ship canal diversion	May 13/64	1.2	206	39	167	130
EWA 3.2	Ditch tributary from Avondale Dairy	Apr. 30/64	16.0	590	52	538	45,000

Table A19-29: Water Quality of Eight Mile Creek Stream Mileage – E 1.0 Lakeshore Road

	Coli- forms MF/100ml	Water Temp. °C	DO (mg/l)	BOD ₅ (mg/l)	Tot. Solids (mg/l)	Susp. Solids (mg/l)	Turb- idity (units)	Cond. 25°C. (umhos/cm ³)	Tot. P asP (mg/l)	Sol. P asP (mg/l)	NH ₃ as N (mg/l)	Tot. KJEL + N (mg/l)	NO ₂ as N (mg/l)	NO ₃ as N (mg/l)	Chlor- ide (mg/l)	Hard- ness (mg/l)	Alk. CaCO ₃ (mg/l)	Tot. Iron (mg/l)	Phenols (ppb)
1. W.Y. 1966/66																			
No. of Samples	9	9	9	8	6	7	6	6	8	8	8	7	8	7	6	3	4	3	4
Maximum	4,100	23.0	13.0	3.0	484	46	41	607	0.30	0.22	0.22	1.50	0.02	2.00	48	275	149	2.45	9.1
Minimum	70	0.6	2.0	1.2	236	4	2.8	360	0.07	0.03	0.00	0.43	0.00	0.00	29	210	119	0.40	7.8
Average		14.5	9.9	2.1	345	17	13	479	0.15	0.11	0.06	0.78	0.00	0.31	37	238	134	1.17	8.5
Median	680																		
2. W.Y. 1966/67																			
No. of Samples	13	14	14	14	14	14	14	14	13	13	13	13	13	12	14	6	10	11	11
Maximum	23,000	24.0	13.0	9.6	896	63	43	1170	3.84	2.62	0.24	9.90	0.03	5.00	103	392	241	5.88	8.8
Minimum	140	0.0	6.0	0.4	222	2	3.1	316	0.00	0.00	0.03	0.33	0.00	0.02	26	140	102	6.15	7.5
Average		11.2	9.0	2.4	458	16	15.9	630.6	0.42	0.27	0.11	1.60	0.01	0.88	40.6	223	147	1.02	8.1
Median	870																		
3. W.Y. 1967/Dec. 68																			
No. of Samples	18	18	18	18	18	18	16	18			18	18	18	18	18	8	8	8	8
Maximum	142,000	23.0	12.0	20.0	925	131	95	1166			1.18	4.45	0.07	3.50	69	496	285	2.05	8.4
Minimum	0	0.0	7.0	0.5	242	1	0	337			0.03	0.20	0.00	0.00	24	138	98	0.36	7.7
Average		10.8	9.3	3.4	456	28	20.5	637			0.27	1.18	0.02	0.84	38	225	176	0.86	8.0
Median	1,185																		
4. 1969																			
No. of Samples	12	14	14	14	14	14	14	14	14	14	14	14	14	12	12	5	5	4	5
Maximum	3,600	23.0	12.0	7.0	930	30	45.1	1241	5.90	4.60	1.50	3.10	0.05	2.00	76	458	411	1.70	8.6
Minimum	40	0.0	5.0	1.0	230	5	3.1	348	0.08	0.05	0.01	0.49	0.00	0.01	19	157	114	0.20	7.8
Average		10.3	8.5	2.8	438	13	17.1	641	1.33	0.85	0.30	1.16	0.02	0.50	35	258	221	0.84	8.2
Median	1,400																		

* BOD₅ – 5-day biochemical oxygen demand
+ KJEL – Kjeldahl nitrogen test

Table A19-30: Welland Ship Canal

Sampling Point		Date	BOD ₅ (ppm)	Solids (ppm)			Turbidity in Silica Units	Coliform Count per 100 ml	Phenols (ppb)
No.	Location			Total	Susp.	Diss.			
SC 8.8	Thorold, Peter Street Bridge	Aug 9/60	1.1				19	70	
		June 18/62	1.4	216			12.5	330	
		Nov 13/63	1.7	236	22	214		530	
SC 9.5	Thorold Street Bridge	Aug 9/60	1.2				10	240	
		Jan 12/61	3.0	176			9	60	
		June 18/62	0.9	216			13.5	8,000	
		Nov 13/63	1.9	224	13	211		470	
SC 11.9	Allanburg Bridge	Aug 9/60	1.6				11	390	
		Jan 12/61	1.6	176			12	190	
		June 18/62	0.7	194			7.5	270	
		Nov 13/63	1.8	230	10	220		510	
SC 14.5	Port Robinson Bridge	Aug 9/60	1.2				10	340	
		Jan 12/61	2.2	174			10	170	
		June 18/62	0.6	206			7.5	800	
		Nov 13/63	2.2	208	6	202		460	
SC 18.5	Main St. Bridge, Welland	Aug 9/60	1.5				7	360	
		June 18/62	1.1	176			5.5	4,000	
		Nov 13/63	1.9	214	12	202		570	4
SC 19.2	Welland, Lincoln St. Bridge	June 18/62	1.6	184			5.0	15,000	
		Nov 13/63	2.2	224	11	213		430	0
SC 19.9	Crowland bridge	Aug 9/60	2.3				7	150	
		Jan 12/61	2.7	182			11	90	
		June 18/62	1.3	196			6	14,000	
		Nov 13/63	2.0	194	10	184		310	0
SC 21.5	Welland junction Bridge	Aug 9/60	1.3				4	1,470	
		Jan 12/61	2.0	180			11	111	
		Jan 18/62	1.1	200			2.3	390	
		Nov 13/63	1.8	234	7	227		650	
SC 25.0	Main St. bridge, Port Colborne	Aug 9/60	1.6				6	114,000	
		Jan 12/61	3.6	194			8	108	
		June 18/62	1.0	220			4.2	7,000	
		Nov 13/63	1.8	224	3	221		830	
SC 26.1	Clarence St. bridge, Port Colborne	Aug 9/60	1.3				3	70	
		June 18/62	0.9	186			1.8	800	
		Nov 13/63	1.7	210	2	208		70	

Table A19-31: Water Quality of Welland Ship Canal Stream Mileage — SC 2.0 Weir Below Lakeshore Road

	Coli- forms MF/100ml	Water Temp. °C	DO (mg/l)	BOD ₅ [*] (mg/l)	Tot. Solids (mg/l)	Turb- idity (units)	Cond. 25°C, (umhos/cm ³)	Tot. P (mg/l)	Sol. P as P (mg/l)	NH ₃ as N (mg/l)	Tot. N KJEL + (mg/l)	NO ₂ N (mg/l)	NH ₃ N (mg/l)	Chlor- ide (mg/l)	Hard- ness (mg/l)	Alk. CaCO ₃ (mg/l)	Tot. Iron (mg/l)	pH	Phenols (ppb)
1. W.Y. 1965/66		7	7	7	6	5	4	7	7	7	7	7	6	5	2	3	2	3	4
No. of Samples		7	7	7	6	5	4	7	7	7	7	7	6	5	2	3	2	3	4
Maximum	1,400	23.0	13.0	3.0	326	87	358	0.13	0.08	0.16	3.30	0.02	0.10	38	140	104	2.80	8.6	2
Minimum	110	7.0	8.0	0.8	226	21	280	0.04	0.02	0.00	0.33	0.00	0.00	25	130	97	1.00	8.3	0
Average		18.1	10.4	1.9	278	45	333	0.08	0.04	0.05	1.01	0.00	0.02	30	135	100	1.90	8.4	1
Median	400																		
2. W.Y. 1966/67		13	14	14	14	14	14	13	13	13	8	13	13	13	10	10	10	10	12
No. of Samples		13	14	14	14	14	14	13	13	13	8	13	13	13	10	10	10	10	12
Maximum	380,000	22.5	13.0	7.0	316	78	362	0.23	0.07	1.31	2.80	0.10	0.20	34	160	197	2.80	9.5	200
Minimum	40	2.0	8.0	0.8	216	14	32.5	0.02	0.00	0.02	0.26	0.00	0.00	26	134	99	1.00	7.9	0
Average		11.7	10.6	2.6	252	41	295.6	0.08	0.02	0.26	0.83	0.01	0.11	28.4	143	111	1.71	8.4	22
Median	4,000																		
3. W.Y. 1967/Dec. 68		18	18	18	18	17	18	18	18	18	18	18	18	18	8	8	8	8	15
No. of Samples		18	18	18	18	17	18	18	18	18	18	18	18	18	8	8	8	8	15
Maximum	49,000	24.0	13.0	5.4	380	87	590	0.19	0.06	0.72	1.36	0.01	15.00	38	184	182	1.88	8.4	12
Minimum	0	0.0	8.0	0.4	212	5	315	0.02	0.00	0.02	0.24	0.00	0.00	24	74	99	0.38	7.8	0
Average		10.9	9.9	1.6	261	40	355	0.08	0.02	0.19	0.65	0.00	0.95	27	140	114	1.41	8.1	3
Median	885																		
4. 1969		11	14	14	14	14	14	14	13	14	14	14	12	12	5	5	4	5	13
No. of Samples		11	14	14	14	14	14	14	13	14	14	14	12	12	5	5	4	5	13
Maximum	43,000	24.0	13.0	7.0	300	60	361	0.19	0.06	0.33	1.54	0.02	0.46	30	152	240	1.98	8.7	20
Minimum	400	0.0	8.0	0.4	190	5	314	0.06	0.01	0.02	0.24	0.00	0.03	5	133	104	0.85	7.9	0
Average		10.1	10.7	1.7	249	36	333	0.08	0.02	0.11	0.58	0.01	0.15	24	143	133	1.51	8.3	6
Median	3,400																		
5. 1970		12	12	12	12	12	12	12	12	12	12	12	12	12	6	6	5	6	11
No. of Samples		12	12	12	12	12	12	12	12	12	12	12	12	12	6	6	5	6	11
Maximum	3,000	24.0	12.0	4.0	750	525	360	0.57	0.16	0.16	1.40	0.01	0.31	35	146	113	4.00	8.3	25
Minimum	12	0.5	8.2	0.6	210	5	312	0.03	0.00	0.01	0.18	0.00	0.03	25	134	100	0.65	7.9	0
Average		9.1	9.8	1.9	292	67	335	0.12	0.03	0.05	0.49	0.01	0.13	28	140	103	1.76	8.2	5
Median																			

* BOD₅ — 5-day biochemical oxygen demand
+ KJEL — Kjeldahl nitrogen test

Table A19-32: Twelve Mile Creek Samples Taken by Conservation Authorities Branch

Sampling Point No.	Location	Date	BOD ₅ (ppm)	Solids (ppm)		Turbidity Units	pH	Anionic Detergents as ABS (ppm)	Phenols (ppb)
				Total	Susp.				
T 0.0	Between Breakwaters at Lake Ontario	June 4/70 (16:00)	2.0	250	10	240	7.7	0.1	
		Aug 31/70 (18:15)	2.5	260	10	250			
T 1.6	Martindale Pond at Hospital	Aug 31/70 (17:10)	3.0	240	15	225			
T 2.0	Queen Elizabeth Hwy.	June 4/70	3.0	250	15	235			
TS 2.9	Effluent from General Motor Plant	Aug 31/70 (17:30)	17	300	15	285	7.6	0.1	
TS 2.9	Warm Effluent from General Motor Plant	Aug 31/70 (17:30)	11	330	15	315			
T 4.3	Below Second Welland Canal (Industrial) Wastes Drain	Aug 7/70 (13:15)	12	340	60	280			35
T 4.4	Upstream Second Welland Canal	Aug 31/70 (18:50)	2.0	270	10	260	25		
T 7.6	De Caw Road	Aug 15/70 (16:00)	1.4	410	10	400			
T 8.3	Parkway Stables	Aug 15/70 (16:15)	0.6	360	5	355			
T 12.1	Just below Effingham Branch	Aug 15/70 (16:30)	1.0	370	5	365			
TEE 12.6	East Branch of Effingham Branch	Aug 15/70 (17:00)	4.0	280	10	270			
TE 13.0	Effingham Branch 0.5 mi downstream of Effingham	Aug 15/70 (16:45)	1.2	300	5	295			

Table A19-33: Twelve Mile Creek (Upstream of De Cew Power Plant)

Sampling Point No.	Location	Date	BOD ₅ (ppm)		Solids (ppm)		Turbidity in Silica Units	Coniform Count per 100 ml	Iron as Fe (ppm)	pH
			Total	Diss.	Susp.	Diss.				
TX 10.4	West branch at Pelham-Thorold Twp. townline	Jun/59	2.6	480			5.0	10,000		
		May/61	2.1	420			3.0	55		
		Oct/61	1.5	528			2.0	310		
		June/62	<4*	426			4.0	1,380		
TA 10.9	E.B. at Pelham-Thorold Twp. townline	June/59	1.3	360			7.0	10,000		
		May/61	2.2	400			7.0	284		
		Oct/61	1.8	348			1.0	99		
		June/62	<4*	408			27.0	3,600		
TA 11.0	Aerial Beacon Branch just above junction	May/61	1.5	408			21	47		
		Oct/61	2.1	414			2.0	124		
		June/62	<4*	560			3.1	2,100		
		June/59	1.8	360			4.0	20,000		
TE 12.1	Effingham Branch just above junction by St. Johns W. Allanburg Road	May/61	2.2	330			3.0	193		
		Oct/61	2.2	326			1.0	109		
		June/62	<4*	320			3.8	12,000		
		June/62	<4*	322			6.0	12,000		
TE 12.8	Effingham Branch in Commerical Park	May/61	2.0	346			2.0	91		
		Oct/61	2.2	314			2.0	153		
		June/62	<4*	334			6.5	51,000		
		June/59	1.5	354			13.0	10,000		
TE 13.6	Effingham Branch at Pelham Road	May/61	2.0	330			3.0	72		
		Oct/61	1.7	326			2.0	300		
		June/62	<4*	326			8.0	59,000		
		Jan/63	3.0	322			5.0	280		
TES 13.6	South branch just above junction	June/59	1.6	686			13.0	20,000		
		May/61	1.5	346			1.0	3		
		Oct/61	790	842			14.0	4,000		
		June/62	<4*	360			1.4	198		
T 12.1	Just above junction Effingham Branch	June/59	1.7	346			9.0	<10,000		
		May/61	2.3	356			5.0	131		
		Oct/61	2.3	396			1.0	22		
		June/62	<4*	382			3.8	970		
T 12.8	St. Johns W. at St. Johns West Fonhill Road	June/59	1.9	336			4.0	20,000		
		May/61	2.2	368			2.0	145		
		Oct/61	1.6	386			1.0	129		
		June/62	<4*	372			4.0	1,500		
T 13.0	East Effingham Branch just above junction at road to St. Johns W.	Oct/61	2.0	312			1.0	236		

* BOD estimates

Table A19-34: Water Quality of Twelve Mile Creek Stream Mileage - T 0.8 Lakeport Road

	Coli- forms MF/100ml	Water Temp. °C	DO (mg/l)	BOD ₅ * (mg/l)	Tot. Solids (mg/l)	Susp. Solids (mg/l)	Turb- idity (units)	Cond. 25°C (umhos/cm ³)	Tot. P asP (mg/l)	Sol. P asP (mg/l)	NH ₃ as N (mg/l)	Tot. KJEL ⁺ N (mg/l)	NO ₂ as N (mg/l)	NO ₃ as N (mg/l)	Chlor- ide (mg/l)	Hard- ness (mg/l)	Alk. CaCO ₃ (mg/l)	Tot. Iron (mg/l)	pH	Phenols (ppb)
1. W.Y. 1965/66																				
No. of Samples	9	9	9	9	9	9	7	7	9	9	8	9	9	9	8	3	3	3	3	3
Maximum	410,000	24.0	12.0	5.6	460	222	71	372	0.26	0.06	0.10	9.90	0.10	0.08	40	160	115	8.00	8.4	
Minimum	1,400	0.0	6.0	2.0	254	18	6.5	345	0.03	0.01	0.00	0.26	0.00	0.00	26	140	100	0.75	7.8	
Average	14.3	8.9	3.9	293	56	36.4		357	0.10	0.03	0.03	1.63	0.01	0.01	29	150	107	3.34	8.0	
Median	51,000																			
2. W.Y. 1966/67																				
No. of Samples	13	15	15	15	15	15	15	15	14	14	14	14	14	14	15	11	11	10	6	
Maximum	120,000	23.0	13.0	8.0	290	28	34	651	0.16	0.07	0.26	1.40	0.02	0.15	29	160	111	1.08	8.4	
Minimum	96	0.5	6.0	1.4	202	9	3	336	0.01	0.00	0.07	0.26	0.00	0.00	22	140	101	0.33	7.2	
Average	10.0	9.1	4.1	244	19	16.7		386	0.06	0.02	0.13	0.73	0.00	0.06	27.1	146	105	0.63	7.9	
Median	26,000																			
3. W.Y. 1967/Dec. 68																				
No. of Samples	18	18	18	18	18	18	17	18	17	17	17	18	18	18	18	8	8	8	8	1.
Maximum	132,000	24.0	14.0	7.2	368	41	38	449			0.26	1.62	0.02	1.50	28	154	109	2.70	8.1	6
Minimum	3,200	0.0	6.0	1.4	216	3	5	325			0.02	0.23	0.00	0.00	24	124	98	0.38	7.8	6
Average	10.5	9.6	3.1	261	19	16.1		362	0.11	0.04	0.05	0.53	0.01	0.09	22	142	106	0.76	8.1	
Median	12,000																			
4. 1969																				
No. of Samples	11	14	14	14	14	14	14	14	14	9	14	14	14	14	11	5	5	4	5	
Maximum	76,000	23.0	12.0	8.5	270	50	71.0	377	0.12	0.04	0.14	0.74	0.02	0.27	29	152	212	1.00	8.5	
Minimum	5,200	0.0	4.2	1.6	200	10	3.8	333	0.03	0.00	0.01	0.28	0.00	0.01	4	135	103	0.40	7.9	
Average	10.0	8.7	3.6	241	20	2.0		351	0.06	0.02	0.05	0.53	0.01	0.09	22	142	127	0.76	8.1	
Median	11,000																			

* BOD₅ - 5-day biochemical oxygen demand
+ KJEL - Kjeldahl nitrogen test

Table 19-35: Water Quality of Twelve Mile Creek 1970

No. of Samples	Coli-forms MF/100ml	Water Temp. °C	DO (mg/l)	BOD ₅ * (mg/l)	Tot. Solids (mg/l)	Susp. Solids (mg/l)	Turbidity (units)	Cond. 25°C, (umhos/cm ³)	Tot. P as P		NH ₃ as N		Tot. N KJEL ⁺ (mg/l)	NO ₂ N (mg/l)	NO ₃ N (mg/l)	Chloride (mg/l)	Hardness (mg/l)	Alk. CaCO ₃ (mg/l)	Tot. Iron (mg/l)	Phenols (ppb)
									as P	as P	as N	as N								
Lakeport Road — Stream Mileage T 0.8																				
12	12	12	12	12	12	12	12	12	12	12	10	12	12	12	9	12	5	6	6	6
Maximum	67,000	24.5	11.5	7.5	260	55	40	363	0.62	0.23	0.05	0.64	0.02	0.20	0.02	28	144	108	1.65	36
Minimum	404	0.5	4.0	1.8	200	5	4	295	0.03	0.00	0.01	0.32	0.00	0.01	0.01	23	132	101	0.35	24
Average		10.8	8.1	3.6	247	15	19	340	0.10	0.02	0.02	0.48	0.01	0.09	0.09	27	139	103	0.80	28
Welland Vale Road — Stream Mileage T 3.4																				
7	7	7	7	7	7	7	7	7	7	7	6	7	7	7	4	7	3	4	4	5
Maximum	360,000	24.0	10.0	5.0	330	50	40	353	0.06	0.00	0.04	0.56	0.02	0.15	0.02	28	150	103	2.70	37
Minimum	256	4.5	7.5	1.4	230	5	8	336	0.04	0.00	0.01	0.30	0.00	0.02	0.02	26	132	99	0.40	23
Average		16.6	8.5	3.2	264	21	24	341	0.05	0.00	0.02	0.42	0.01	0.07	0.07	27	139	101	1.41	28
Second Welland Canal — Glen Ridge Avenue — Stream Mileage T 4.4																				
7	7	7	7	7	7	7	5	7	7	7	7	7	7	7	5	7	3	4	4	6
Maximum	660,000	23.0	8.0	3.00	1,490	290	150	1,282	2.50	0.17	2.00	26.00	0.60	0.12	0.99	200	167	3.00	8.1	430
Minimum	1,590	9.5	0.0	1.2	270	15	25	329	0.05	0.00	0.01	0.34	0.01	0.01	0.01	27	132	101	0.90	26
Average		19.0	3.0	155	915	132	77	915	0.76	0.08	0.56	6.01	0.12	0.04	0.04	46	157	125	2.18	245
Gendale Avenue — Stream Mileage T 5.4																				
7	7	7	7	7	7	7	7	7	7	7	6	7	7	7	6	7	3	4	4	6
Maximum	1,100	23.0	11.0	2.5	260	35	30	337	0.05	0.01	0.47	0.60	0.02	0.18	0.27	150	102	1.20	8.4	31
Minimum	32	4.0	7.0	0.8	200	5	10	324	0.04	0.00	0.01	0.27	0.00	0.02	0.02	25	128	98	0.95	22
Average		15.5	8.8	1.6	239	14	22	330	0.05	0.00	0.09	0.40	0.01	0.09	0.09	26	137	100	1.06	25

* BOD₅ - 5-day biochemical oxygen demand
+ KJEL - Kjeldahl nitrogen test

Table A19-36: Gibson Lake System

Sampling Point			BOD ₅	Solids (ppm)			Turbidity	Coliform
No.	Location	Date	(ppm)	Total	Susp.	Diss.	in Silica	Count
TB 0.3	HEPC power headworks	May/61	3.0	236			6.0	3
		Oct/61	1.2	248			9.0	4,100
		June/62	<4*	228			11.0	830
		Jan/63	3.2	210			5.0	340
TB 1.5	Merrittville Rd.	June/59	6.0	242			16.0	<10,000
		May/61	3.1	228			6.0	
		Oct/61	1.6	242			5.0	1,120
		June/62	<4*	250			9.5	4,000
		Jan/63						530
TB 2.5	Beaver Dams Cr.	May/61	9.0	246			9.0	43
	Branch at Beaver	Oct/61	8.0	248			6.0	1,470
	Dams Road	June/62		244			11.5	870
		Jan/63	3.6	248			7.5	560
		Aug 6/70	13.0	290	40	250		
TBE 3.0	Tributary to Gibson	Jan /63	2.4	280			5.5	230,000
	Lake at road to							
	Beaver Dams Village							
TBC 2.4	Canal branch at	May /61	2.8	250			6	6
	Beaver Dams Rd.	Oct /61	1.3	234			8	1,340
		June/62	<4*	214			9.5	230
		Jan/63	2.2	224			3.8	78
TBC 3.4	Dam at Third	June/62	<4*	222			10.5	330
	Welland Canal							
TBC 4.6	Ship Canal diversion	Oct/61	1.4	244			7	1,060
	at Hwy. 20	June/62	2.2	224			3.8	78
		Jan/63		234			12.5	9,000
TD 0.0	De Cew Falls Branch	May/61	2.6	246			4	8
	at road above falls	Oct/61	1.5	222			6	10
		June/62	<4*	196			3.5	4,300
		Jan/63	3.4	208			5.0	160
TD 0.6	De Cew Falls branch	Oct/61	1.0	222			7.0	670
	at Greenbridge Rd.	June/62	<4*	198			3.1	400
					</			

* BOD estimates

Table A19-37: Second Welland Canal (Industrial Wastes Drain)

Sampling Point No.	Description	Date	BOD ₅ (ppm)		Solid (ppm)		Turbidity in Silica Units	Coliform Count per 100 ml	Iron as Fe	pH
			Total	Susp.	Total	Susp.				
TW 8.7	Thorold-St. Catharines	Mar/64	230	252	1530	252	1278	1,900,000	2.12	7.9
Townline Rd.										
TW 8.8	Foot bridge 200 yards below Thorold Pulp Co. (no longer exists)	June/59	113	736	1080	736	344	10,000,000		
		Oct/61	180	242	1020	242	778	850,000		
		June/62			1994			2,470,000		
TW 9.8	Lyndon St. bridge	Jan/63	175	190	1164	190	794	98,000		
		Jan/63	160	1134	1134	115	1019	109,000		
		Mar/64	210	80	1468	80	1388	3,700,000	3.45	7.2
TW 10.1	Beaver Dams Road	May/61	145	192	1072	192	880	3,000		
		Oct/61	140	986	986	118	868	410,000		
		June/62			2168			2,570,000		
TW 10.4	Outlet from Ship Canal	Jan/63	195	122	1214	122	1092	88		
		Mar/64	205	100	1544	100	1444	150,000	3.75	7.4
		Jan/63	<4*	212	212			12,000	0.15	8.0
		Mar/64	2.0	3.0	194	3.0	191	20		

* BOD estimates

Table A19-38: Water Quality of Fifteen Mile Creek Stream Mileage — V 2.3 Fourth Avenue

	Coli- forms MF/100ml	Water Temp. °C	DO (mg/l)	BOD ₅ * (mg/l)	Tot. Solids (mg/l)	Turb- idity (units)	Cond. 25°C. (umhos/cm ²)	Tot. P asP (mg/l)	Sol. P asP (mg/l)	NH ₃ N (mg/l)	Tot. KjEL ⁺ N (mg/l)	NO ₂ as N (mg/l)	NO ₃ as N (mg/l)	Chlor- ide (mg/l)	Hard- ness (mg/l)	Alk. CaCO ₃ (mg/l)	Tot. Iron (mg/l)	Phenols (ppb)
1. W.Y. 1965/66																		
No. of Samples	9	9	9	9	9	8	6	7	9	9	9	9	9	9	3	3	3	3
Maximum	12,000	24.0	11.0	6.5	644	30	40.0	825	0.18	0.09	0.31	14.00	0.02	4.00	74	270	134	4.40
Minimum	24	0.0	7.0	1.6	114	5	6.0	226	0.05	0.01	0.03	0.26	0.00	0.00	10	110	61	1.21
Average	14.7	9.3	9.3	2.6	388	21	27.7	554	0.11	0.04	0.11	2.50	0.00	0.61	36	200	109	2.34
Median	340																	8.3
2. W.Y. 1966/67																		
No. of Samples	15	15	15	15	15	15	15	15	14	14	14	14	14	15	6	11	11	11
Maximum	11,000	23.5	12.0	9.2	994	64	95	1408	0.18	0.07	0.72	3.30	0.05	3.00	161	326	182	3.90
Minimum	10	0.0	4.5	1.0	266	13	6.5	267	0.01	0.00	0.03	0.52	0.00	0.02	10	160	55	0.87
Average	10.6	8.5	8.5	2.6	478	29	38.9	653.1	0.07	0.02	0.19	1.08	0.01	0.76	59.4	279	125	1.80
Median	350																	8.0
3. W.Y. 1967/Dec. 68																		
No. of Samples	18	18	18	18	18	18	17	18		18	18	18	18	18	3	8	8	8
Maximum	12,000	24.0	12.0	8.4	568	135	77	836		0.86	2.45	0.05	2.40	84	346	182	3.40	8.2
Minimum	4	0.0	7.0	0.2	232	9	9	311		0.02	0.10	0.00	0.00	15	92	62	0.59	7.7
Average	10.7	9.3	9.3	1.9	434	30	32	595		0.20	0.88	0.01	0.39	46	253	132	1.53	8.0
Median	177																	
4. 1969																		
No. of Samples	11	14	14	14	14	14	14	14	14	12	14	14	14	11	5	5	4	5
Maximum	65,000	23.5	12.0	3.5	570	100	84	892	0.28	0.17	0.34	1.40	0.06	1.70	84	356	295	170
Minimum	68	0.0	6.0	0.6	210	5	9	243	0.01	0.01	0.01	0.44	0.00	0.01	6	168	109	0.40
Average	11.7	9.1	9.1	1.7	415	31	35.7	567	0.10	0.05	0.12	0.85	0.01	0.46	41	277	186	0.79
Median	150																	8.1

* BOD₅ — 5-day biochemical oxygen demand
+ KJEL — Kjeldahl nitrogen test

Table A19-39: Fifteen Mile Creek

Sampling Point No.	Location	Date	BOD ₅ (ppm)	Solids (ppm)			Turbidity in Silica Units	Coliform Count per 100 ml
				Total	Susp.	Diss.		
V 8.7	Sideroad east of North Pelham	Sept/61	0.2	338	2	336		70
V 9.5	Road between Conc. 2 & 3 Pelham Twp.	Sept/61	1.6	414	6	408		250
V 12.3	Conc. Road through Silverdale	Sept/61	0.8	426	84	342		210
Sixteen Mile Creek								
S 5.2	Rockway Road Conc. 7 Louth Twp.	Sept/61	1.9	400	22	378		152
S 8.8	Pelham-Gainsborough Townlines	Aug/60	2.0				3	140
		Sept/61	3.5	488	42	446		230

Table A19-40: Water Quality of Sixteen Mile Creek Stream Mileage – S 2.0 Fourth Avenue

	Coli- forms MF/100ml	Water Temp. °C	DO (mg/l)	BOD ₅ * (mg/l)	Tot. Solids (mg/l)	Turb- idity (units)	Cond. 25°C (umhos/cm ³)	Tot. P asP (mg/l)	Sol. P asP (mg/l)	NH ₃ N (mg/l)	Tot. N KJEL ⁺ (mg/l)	NO ₂ N (mg/l)	NO ₃ N (mg/l)	Chlor- ide (mg/l)	Hard- ness (mg/l)	Alk. CaCO ₃ (mg/l)	Tot. Iron (mg/l)	Phenols (ppb)	pH
1. W.Y. 1965/66	8	8	8	7	7	7	5	7	6	7	7	7	7	7	3	3	3	3	
No. of Samples	30,000	25.0	11.2	3.4	666	60	598	750	0.22	0.10	0.30	1.70	0.02	1.00	55	300	130	3.28	8.9
Maximum	70	0.3	6.0	2.0	240	14	12	235	0.05	0.01	0.03	1.00	0.00	0.00	10	110	61	0.56	7.9
Minimum		14.5	9.0	2.6	436	28	122.2	498	0.11	0.05	0.17	1.27	0.00	0.17	32	200	105	1.75	8.2
Average	352																		
Median																			
2. W.Y. 1966/67	15	15	15	15	15	15	15	14	14	13	14	14	14	14	10	10	10	10	10
No. of Samples	7,700	23.5	12.0	10.0	982	108	110	1178	0.21	0.07	0.33	1.70	0.10	27.50	82	328	211	5.15	8.9
Maximum	300	1.0	5.0	1.2	242	7	3.6	277	0.01	0.00	0.02	0.64	0.00	0.02	12	110	50	0.14	7.6
Minimum		11.2	8.6	2.9	483	47	39.6	623	0.10	0.03	0.13	1.11	0.02	3.30	41.4	231	125	1.89	8.0
Average	1,010																		
Median																			
3. W.Y. 1967/Dec. 68	18	18	18	18	18	18	17	18		18	18	18	18	18	8	8	8	8	8
No. of Samples	23,000	23.0	12.0	11.0	554	115	87.0	755		1.51	3.65	0.07	3.10	72	316	174	4.00	8.2	8.2
Maximum	0	0.0	5.0	0.3	254	10	7.5	315		0.05	0.11	0.00	0.00	16	92	62	0.28	7.6	7.6
Minimum		10.2	9.0	2.1	426	29	33.5	575		0.29	1.03	0.01	0.63	33	244	118	1.76	8.0	8.0
Average	325																		
Median																			
4. 1969	11	14	14	14	14	14	14	14	14	14	14	14	14	14	5	5	4	5	5
No. of Samples	3,600	23.0	12.0	4.0	700	70	70	980	0.42	0.18	0.50	1.60	0.08	2.60	56	460	237	1.35	8.5
Maximum	76	0.0	5.0	0.4	210	5	4	274	0.01	0.00	0.02	0.56	0.00	0.02	7	174	116	0.30	7.5
Minimum		0.7	8.3	2.2	389	27	30.7	541	0.13	0.06	0.13	1.04	0.02	0.67	28	289	168	0.80	8.1
Average	390																		
Median																			

* BOD₅ – 5-day biochemical oxygen demand
+ KJEL – Kjeldahl nitrogen test

Table A19-41: Water Quality of Twenty Mile Creek Stream Mileage — J 2.4

	Coli- forms MF/100ml	Water Temp. °C	DO (mg/l)	BOD ₅ * (mg/l)	Tot. Solids (mg/l)	Susp. Solids (mg/l)	Turb- idity (units)	Cond. 25°C (umhos/cm ³)	Tot. P as P (mg/l)	Sol. P as P (mg/l)	NH ₃ as N (mg/l)	Tot. KJEL+ N (mg/l)	NO ₂ as N (mg/l)	NO ₃ as N (mg/l)	Chlor- ide (mg/l)	Hard- ness (mg/l)	Alk. CaCO ₃ (mg/l)	Tot. Iron (mg/l)	Phenols (ppb)	pH
1. W.Y. 1965/66																				
No. of Samples	9	9	9	9	9	8	7	1,310	5	9	8	9	8	9	8	7	3	3	3	3
Maximum	4,900	25.0	13.0	3.6	896	78	65	1,310	0.35	0.09	0.33	1.50	0.02	2.60	264	300	143	7.20	8.5	
Minimum	29	0.4	11.0	1.6	306	14	2.6	554	0.03	0.00	0.00	0.86	0.00	0.00	14	120	101	1.01	7.3	
Average		15.4	11.9	2.3	538	29	25.4	818	0.10	0.03	0.11	1.03	0.01	0.83	72	223	125	3.17	8.0	
Median	530																			
2. W.Y. 1966/67																				
No. of Samples	15	14	14	14	13	14	14	14	13	13	13	13	13	13	14	10	9	10	6	
Maximum	29,000	22.0	13.0	4.0	1,030	82	100	1,519	1.64	0.73	0.46	2.30	0.04	62.50	264	432	231	3.88	8.4	
Minimum	70	0.0	5.0	1.0	286	6	4.5	279	0.03	0.00	0.02	0.39	0.00	0.00	8.0	110	55	0.25	7.4	
Average		10.7	9.1	2.2	566	29	29.8	744	0.20	0.09	0.20	1.17	0.01	5.94	63.9	273	145	1.30	8.0	
Median	500																			
3. W.Y. 1967/Dec.68																				
No. of Samples	18	18	18	18	18	18	18	18												
Maximum	27,000	23.0	12.0	13.0	1,364	76	95	1,900			1.20	3.30	0.12	3.00	174	480	210	35.00	8.2	
Minimum	16	0.0	4.0	0.7	283	2	1.8	266			0.02	0.34	0.00	0.00	16	124	63	0.14	7.8	
Average		10.7	9.6	3.2	536	24	28.5	720			0.24	1.07	0.02	0.96	51	323	159	5.44	8.0	
Median	840																			
4. 1969																				
No. of Samples	9	12	12	12	12	12	12	12	12	12	12	12	12	12	10	9	3	2	3	
Maximum	2,100	22.0	12.0	5.0	1,132	140	80	1,650	1.50	0.15	0.66	1.50	0.07	1.90	318	668	199	0.40	8.4	
Minimum	32	0.0	7.0	0.4	160	2	3	217	0.02	0.01	0.05	0.15	0.00	0.01	10	204	180	0.35	8.0	
Average		11.5	9.0	2.2	505	28	27.3	709	0.30	0.06	0.21	0.86	0.02	0.73	74	409	190	0.37	8.3	
Median	250																			
5. 1970																				
No. of Samples	12	12	12	12	12	12	12	12	12	12	12	12	12	12	11	12	5	5	5	
Maximum	81,000	25.0	11.0	5.0	1050	130	70	1,344	0.40	0.13	0.36	1.90	0.06	5.90	151	464	186	3.35	8.1	
Minimum	8	0.0	6.0	0.8	205	5	3	305	0.05	0.01	0.03	0.62	0.00	0.07	18	152	70	0.30	7.8	
Average		10.4	8.8	2.3	525	20	22	735	0.17	0.07	0.18	1.16	0.03	1.81	61	310	142	1.52	8.0	
Median																				

* BOD₅ — 5-day biochemical oxygen demand
+ KJEL — Kjeldahl nitrogen test

Table A19-42: Water Quality of Thirty Mile Creek Stream Mileage — T 0.5 Queen Elizabeth Highway

	Coli- forms MF/100ml	Water Temp. °C	DO (mg/l)	BOD ₅ * (mg/l)	Tot. Solids (mg/l)	Susp. Solids (mg/l)	Turb- idity (units)	Cond. 25°C (umhos/cm ³)	Tot. P as P (mg/l)	Sol. P as P (mg/l)	NH ₃ N (mg/l)	Tot. KJEL+ N (mg/l)	NO ₂ N (mg/l)	NO ₃ N (mg/l)	Chlor- ide (mg/l)	Hard- ness (mg/l)	Alk. CaCO ₃ (mg/l)	Tot. Iron (mg/l)	Phenols (ppb) pH
1. W. Y. 1965/66																			
No. of Samples	9	9	9	9	8	8	7	6	8	7	8	9	9	9	8	3	3	3	3
Maximum	90,000	20.0	16.0	13.0	1,000	122	27	1,210	6.05	0.12	0.50	2.50	0.20	4.00	203	360	182	2.03	8.7
Minimum	300	0.5	8.0	1.1	222	15	2.8	258	0.02	0.01	0.00	0.71	0.00	0.00	10	140	71	0.14	7.8
Average	14.0	11.2	3.7	558	38	11.8		741	0.83	0.05	0.13	1.09	0.04	1.39	78	256	131	0.96	8.1
Median	1,900																		
2. W. Y. 1966/67																			
No. of Samples	14	15	15	15	15	15	14	14	14	13	14	14	14	14	14	10	9	10	6
Maximum	2,300,000	22.0	13.0	13.0	786	160	74	1,050	1.05	0.82	0.79	2.80	0.06	10.00	120	428	177	4.65	8.3
Minimum	310	0.4	5.0	1.1	252	5	2.6	294	0.01	0.00	0.02	0.52	0.00	0.05	12	120	63	0.12	7.7
Average	10.6	9.0	2.9	490	27	18.3		652.6	0.13	0.09	0.22	1.15	0.02	2.54	57.1	276	134	0.95	8.1
Median	4,650																		
3. W. Y. 1967/Dec. 68																			
No. of Samples	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	8	8	8	8
Maximum	26,000	22.0	13.0	4.4	780	111	68	1,083	0.52	1.80	0.79	5.00	0.16	14	125	456	228	2.40	8.2
Minimum	52	0.0	6.0	0.4	282	5	2	349	0.06	0.44	0.01	0.16	0.16	14	60	83	0.16	7.6	
Average	10.3	10.3	1.8	493	19	14.4		683	0.19	0.86	0.07	2.11	0.07	2.11	58	330	182	0.74	7.9
Median	2,600																		
4. 1969																			
No. of Samples	11	14	14	14	14	14	14	14	14	13	14	14	14	13	11	5	5	4	5
Maximum	13,700	21.0	14.0	6.0	800	60	115	1,266	0.49	0.12	0.90	1.30	0.12	6.40	168	528	248	0.50	8.8
Minimum	192	0.0	6.0	0.6	230	5	2	318	0.04	0.02	0.02	0.37	0.01	0.13	10	258	136	0.05	7.2
Average	10.7	9.7	1.9	485	14	17.3		696	0.12	0.06	0.19	0.75	0.03	2.74	67	374	191	0.30	8.2
Median	1,270																		
5. 1970																			
No. of Samples	12	12	12	11	12	12	12	12	12	12	12	12	12	12	12	5	5	5	5
Maximum	13,300	23.8	12.0	4.0	740	35	40	1,009	0.40	0.20	0.50	1.50	0.08	5.90	107	436	206	1.10	8.1
Minimum	72	0.5	5.0	1.4	190	5	2	312	0.04	0.00	0.01	0.46	0.01	0.55	12	160	83	0.20	7.8
Average	10.1	10.2	2.3	432	11	15		625	0.15	0.06	0.10	0.92	0.03	1.79	56	285	152	0.63	7.9
Median																			

*BOD₅ — 5-day biochemical oxygen demand
+ KJEL — Kjeldahl nitrogen test

Table A19-43: Water Quality of Forty Mile Creek Stream Mileage — FO 0.3 Downstream From the Town of Grimsby

	Coli- forms MF/100ml	Water Temp. °C	DO (mg/l)	BOD ₅ * (mg/l)	Tot. Solids (mg/l)	Susp. Solids (mg/l)	Turb- idity (units)	Cond. 25°C (umhos/cm ³)	Tot. P		NH ₃ as N (mg/l)	NO ₂ as N (mg/l)		NO ₃ as N (mg/l)	Chlor- ide (mg/l)	Hard- ness (mg/l)	Alk. CaCO ₃ (mg/l)	Tot. Iron (mg/l)	Phenols pH (ppb)
									as P (mg/l)	as P (mg/l)									
1. W.Y. 1965/66	9	9	9	9	8	8	8	7	8	9	9	9	9	9	9	3	3	3	3
No. of Samples	9,000,000	230	12.0	21.0	678	64	38	1410	8.50	7.18	3.68	7.30	1.00	7.50	196	580	185	3.42	7.8
Maximum	3,500	1.0	5.5	1.6	246	10	2.9	240	0.03	0.01	0.06	0.71	0.01	0.22	12	110	58	0.41	7.1
Minimum	Average	14.4	8.2	7.7	511	36	22.4	900	3.77	2.83	1.14	3.67	0.22	2.79	78	343	124	1.43	7.5
Median	100,000																		
2. W.Y. 1966/67	15	15	15	14	14	14	13	14	13	13	13	13	13	13	14	6	10	11	11
No. of Samples	56,000,000	20.0	11.0	86.0	1810	304	84	2540	9.62	13.20	18.00	0.60	6.25	477	1076	207	7.90	8.4	
Maximum	4	2.0	0.5	2.7	274	9	5	309	0.16	0.01	0.41	1.10	0.00	0.00	12	200	50	0.30	7.1
Minimum	Average	11.0	7.0	16.6	748	54	38	1026	1.93	1.67	2.78	6.47	0.11	1.60	136.6	411	135	2.31	7.6
Median	17,000																		
3. W.Y. 1967/Dec. 68	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	8	8	8	1
No. of Samples	1,700,000	22.0	11.0	80	1594	130	59	2261											
Maximum	4	1.0	3.0	2.5	190	8	4.2	220											10
Minimum	Average	12.0	6.4	16.3	714	31	22.9	996											10
Median	12,300																		10
4. 1969	11	14	14	14	14	14	14	14	14	14	14	14	14	13	11	5	5	4	5
No. of Samples	97,000,000	20	9.0	500	2070	570	240	2860	43.00	13.00	26.00	28.00	0.98	9.00	494	620	330	9.50	8.2
Maximum	8	4	2.2	4.0	210	5	10	241	0.24	0.18	0.10	0.92	0.05	0.03	8	258	171	0.20	7.2
Minimum	Average	12.5	6.0	67.2	960	92	49.4	1246	7.20	4.80	7.01	17.17	0.26	2.44	146	380	227	2.61	7.6
Median	123,000																		
5. 1970	12	12	12	12	12	12	12	12	12	11	12	12	12	12	12	5	5	5	5
No. of Samples	207,000	21.5	11.0	32.0	1150	90	70	1,660	10.00	6.00	28.00	31.00	2.40	13.00	241	496	230	1.60	7.8
Maximum	4	2.0	2.0	4.5	180	10	8	258	0.36	0.16	0.13	1.40	0.02	0.03	14	174	83	0.15	7.0
Minimum	Average	10.6	6.7	13.9	580	29	25	805	3.11	2.26	4.68	7.11	0.52	3.28	88	289	137	0.88	7.5
Median																			

* BOD₅ — 5-day biochemical oxygen demand

+ KJEL — Kjeldahl nitrogen test

Table A19-44: Welland River and Tributaries

Sampling Point No.	Description	Date	BOD5 (ppm)	Total Solids (ppm)	Susp. Solids (ppm)	Turbidity in Silica Units	Coliform Count per 100 ml	Phenols (ppb)	Iron as Fe (ppm)
PW 9.2	Welland River at Montrose Bridge	June/59	2.8	190	4	16	300		
		Feb/61	4.2	220		5	5,000		
		June/62	2.2	196		1.7	14,100	2.0	
		May/63	2.6	200		5.5	730		
		Sep/63	1.2	188	2		3,800		
		Apr/64						5.0	3.9
PWT 9.8	Thompsons Cr. at Port Robinson Rd. just above junction	June/59	1.6	336	50	26	66		
		Feb/61	9.0	608	406		30		
		June/62	21.0	594	53		239,000		
		May/63	2.0	1566	300	525	11,000	10	
		Sept/63	19.0	1640	220		<100,000	0	
PWT 10.8	Thompsons Cr. just below Cyanamid plant	June/59	12.0	302	168		20		
		June/62	205	824	195		24,000,000		
		May/63	2.4	2080	300		90	12	18
		Sept/63	28	730	106		2,300	0	
PW 11.7	Welland River opposite sideroad 2½ miles west of power canal	June/59	2.8	200	10	12	300		
		Feb/61	3.7	198		2	500		
		June/62	2.8	292	4.5		8,000		
		May/63	2.0	1242		250	<10	6	3.0
		Sept/63	4.6	246	27		5,000		
PW 14.6	Welland River Bridge, Port Robinson just east of ship canal	June/59	1.9	196	16	7	400		
		Feb/61	3.2	194		2	510		
		June/62	1.8	272		34	41,000		
		May/63	3.7	236		21	80,000		
		Sept/63	2.6	220	30		31,000		
		Mar/64		210					13.0
PW 17.4	Welland River north of Dawns Drive — Welland	June/59	7.1	262	74	34	3,000		
		Feb/61	4.9	182		2	5,800		
		June/62	2.8	240		7.0	176,000		
		May/63	6.0	260		11.0	113,000		
		Sept/63	25	452	220		410,000		
PW 18.6	Welland River at bridge just west of ship canal	June/59	3.0	216	26	33.0	180,000		
		Feb/61	8.0	216		2	97,000		
		June/62	1.1	212		27.0	<1,500,000		
		May/63	3.8	236		6.5	131,000		
		Sept/63	2.2	230	22		210,000		
PWX 20.1	Coyle Cr. at bridge just above mouth	June/59	2.8	308	56		1,000		
		Feb/61	10	324		14	60		
		June/62	3.2	316	93		25,000		
		May/63	3.5	320		26	60,000		
		Sept/63	1.6	246	47		100,000		
PWFC 20.8	Disused Feeder Canal just above outlet to Welland River (Brown Tap Drain)	May/61	2.0	312	12	9	1,020		
		Apr/64	33.0	378	44		1,000		

Table A19-44: Welland River and Tributaries — *Continued*

Sampling Point No.	Description	Date	BOD5 (ppm)	Total Solids (ppm)	Susp. Solids (ppm)	Turbidity in Silica Units	Coliform Count per 100 ml	Phenols (ppb)	Iron as Fe (ppm)
PWFC 23.1	Disused Feeder Canal at Regional Road 23	May/61	6.0	290	40	43	20		
PWFC 31.4	Disused Feeder Canal at sideroad crossing south of Winger	May/61	3.6	244	26	19	52		
PW 21.2	Welland River opposite Pelham Twp. — Welland Line	June/59	14	344	64	87	50,000		
		Feb/61	5.6	264		2	7,700		
		June/62	2.8	300		45	39,000		
		May/63	4.4	396		65	37,000		
		Sept/63	2.6	342	54		6,000		
PWT 25.6	Forks Cr. at Hwy. 3A	July/59	9.2	284	46		100		
		Feb/61	5.3	396		3	39		
		June/62	2.0	322		43	25,000		
		May/63	3.2	340		53	360		
PFW 28.5	Wainfleet Br. Forks Cr. at Conc. Road 4 & 5 Wainfleet Township	June/59	3.6	560	70		10,000		
		Feb/61	14.0	798		10	5		
		June/62	4.4	436		48	109,000		
		May/63	3.4	460		59	5,000		
PWF 28.9	Forks Cr. at Hwy. 3A just north of Chambers Corner	June/59	5.0	432	70		100		
		Feb/61	30	566		34	110		
		June/62	2.6	462		48	61,000		
		May/63	2.8	490		50	150		
		Sept/63	2.6	410	23		100		
PWFR 32.3	Branch from Winger (just below) beside Hwy. 3.	June/59	95	4326	72		<10,000,000		
		Feb/61	1,000	4364	196		700		
		June/62	3.6	348		9.0	66,000		
		May/63	3.1	792		8.0	5,000		
PW 27.0	Welland River just opposite junction of 3A and 57 Hwys.	June/59	3.2	286	38	58	71		
		Feb/61	4.0	342		5	2,500		
		June/62	1.8	328		45	10,000		
		May/63	2.5	348		45	1,010		
		Sept/63	3.0	346	20		900		
PW 35.2	Welland River ½ mile below Wellandport beside Hwy. 57	June/59	5	356	26	42	600,000		
		Feb/61	6.5	570		4	0		
		June/62	2.6	360		43	5,000		
		May/63	2.8	282		17	410		
		Sept/63	1.8	380	21		180		
		Apr/64						3.3	9.8
PWO 42.3	Oswego Cr. at Rd. just above junction	June/59	10	372	48	70	100		
		Feb/61	6.7	1424		8	20		
		June/62	4.8	466		42	8,000		
		May/63	4.1	342		18	380		
		Sept/63	2.8	428	39		210		
PW 42.9	Welland River at Talbot Rd. just west of Pt. Davidson station	June/59	5	342	32	65	36		
		Feb/61	9.4	1332		6	20		
		June/62	4.8	520		50	11,000		
		May/63	5.0	414		53	1,000		
		Sept/63	3.2	616	67		600		
PW 52.2	Welland River at Warner on Smithville — Canborough Rd.	Feb/61	8.0	5308		9	20		
		June/62	2.0	722		41.0	17,000		
		May/63	2.8	466		13.0	320		
		Sept/63	1.8	988	7		1,500		

Table A19-45: Water Quality of Welland River Stream Mileage — PW 14.6 Port Robinson Bridge

	Coli- forms MF/100ml	Water Temp. °C	DO (mg/l)	BOD ₅ * (mg/l)	Tot. Solids (mg/l)	Turb- idity (units)	Cond. 25°C (umhos/cm ²)	Tot. P as P (mg/l)	Sol. P as P (mg/l)	NH ₃ as N (mg/l)	Tot. KJEL ⁺ (mg/l)	NO ₂ as N (mg/l)	NO ₃ as N (mg/l)	Chlor- ide (mg/l)	Hard- ness (mg/l)	Alk. CaCO ₃ (mg/l)	Tot. Iron (mg/l)	Phenols pH (ppb)
1. W. Y. 1965/66																		
No. of Samples	9	9	9	9	9	9	8	7	9	8	9	9	8	9	3	3	3	3
Maximum	118,000	25.0	12.0	7.3	324	133	85.0	383	0.27	0.16	0.66	1.80	1.25	33	150	109	4.10	8.3
Minimum	100	0.2	5.0	0.6	98	15	9.5	280	0.05	0.03	0.00	0.40	0.00	14	136	99	0.50	8.1
Average		14.7	8.8	3.8	252	44	37.2	352	0.18	0.08	0.24	1.21	0.03	27	145	102	2.73	8.2
Median	7,000																	
2. W. Y. 1966/67																		
No. of Samples	10	12	12	12	12	12	12	12	11	11	6	11	11	11	8	8	8	8
Maximum	280,000	22.5	11.0	5.2	366	90	120	446	0.20	0.13	0.43	1.65	0.09	200	170	106	8.00	8.4
Minimum	384	0.5	3.0	1.5	182	15	7.5	310	0.01	0.00	0.02	0.20	0.00	12.0	32	51	0.88	6.8
Average		9.5	8.1	2.7	263	32	49.1	377.3	0.08	0.05	0.22	0.77	0.03	23.9	130	87	3.72	7.7
Median	3,110																	
3. W. Y. 1967/Dec. 68																		
No. of Samples	18	18	18	18	18	17		18	18	18	18	17	18	18	7	8	8	11
Maximum	420,000	22.0	12.0	4.4	386	92	100	477		1.10	2.10	0.07	2.20	32	184	112	4.90	20
Minimum	320	0.0	3.0	1.4	206	6	11.5	310		0.02	0.52	0.00	0.06	16	140	80	0.60	0
Average		10.4	6.3	2.8	279	35	33.4	390		0.59	1.40	0.04	0.58	23	166	104	1.86	5
Median	46,500																	
4. 1969																		
No. of Samples	11	14	14	14	14	14		14	14	13	14	12	12	13	5	4	3	4
Maximum	52,000	25.0	10.0	6.0	380	190	150	527	0.55	0.18	1.60	2.80	0.13	200	201	108	1.09	8.0
Minimum	4,600	0.0	3.8	1.2	215	5	9.0	230	0.11	0.01	0.20	0.58	0.01	9	160	98	0.30	7.8
Average		11.6	6.9	2.9	298	51	47.6	390	0.25	0.08	0.48	1.27	0.04	24	177	103	0.75	7.9
Median	15,000																	
5. 1970																		
No. of Samples	12	12	12	12	12	12	12	12	12	12	12	12	12	11	6	6	4	5
Maximum	81,000	24.0	10.5	4.0	320	75	110	404	0.52	0.23	0.66	1.80	0.52	190	172	107	5.50	7.9
Minimum	220	0.0	3.5	1.6	165	5	10	248	0.13	0.00	0.22	0.73	0.02	13	136	64	0.20	7.9
Average		10.4	7.1	2.7	262	22	41	360	0.24	0.10	0.40	1.22	0.09	24	149	94	2.04	7.9
Median																		

* BOD₅ — 5 day biochemical oxygen demand
+ KJEL — Kjeldahl nitrogen test

Table A19-46: Water Quality of Welland River Stream Mileage — PW 9.2 Montrose Bridge

	Coli- forms MF/100ml	Water Temp. °C	DO (mg/l)	BOD ₅ * (mg/l)	Tot. Solids (mg/l)	Turb- idity (units)	Cond. 25°C (umhos/cm ³)	Tot. P asP	Sol. P asP	NH ₃ N	Tot. KJEL ⁺ (mg/l)	NO ₂ as N (mg/l)	NO ₃ N (mg/l)	Chlor- ide (mg/l)	Hard- ness (mg/l)	Alk. CaCO ₃ (mg/l)	Tot. Iron (mg/l)	Phenols (ppb)
1. W.Y. 1965/66																		
No. of Samples	8	8	8	7	7	7	5	7	5	6	7	6	6	7	1	1	1	1
Maximum	3,500	25.5	12.0	9.2	368	43	456	2.42	0.57	9.84	85.80	0.18	2.00	47				
Minimum	16	1.1	6.0	1.2	198	15	332	0.03	0.00	0.06	0.46	0.00	0.00	19				
Average		16.3	8.3	3.6	261	22	395	0.55	0.24	5.89	20.56	0.05	0.78	32	130	93	0.27	8.3
Median	425																	
2. W.Y. 1966/67																		
No. of Samples	11	12	12	11	12	12	11	11	11	10	6	11	11	10	8	8	8	8
Maximum	70,000	21.0	11.0	6.2	470	116	559	0.52	0.49	8.20	21.50	0.06	5.00	37	160	180	5.60	8.6
Minimum	4	1.0	7.0	0.7	118	9	307	0.01	0.01	0.08	0.58	0.00	0.02	13	100	66	0.11	7.4
Average		8.8	9.0	3.7	295	42	382.9	0.21	0.16	3.01	10.05	0.03	1.81	24.5	139	107	2.41	8.35
Median	950																	
3. W.Y. 1967/Dec. 68																		
No. of Samples	18	18	18	18	17	17	18			18	18	17	17	18	8	8	8	8
Maximum	200,000	23.0	14.0	6.0	550	93	702			12.00	18.00	0.19	6.80	33	176	114	4.40	8.8
Minimum	60	0.0	5.0	0.6	180	3	208			0.00	0.00	0.00	0.00	18	134	96	0.41	7.6
Average		9.6	8.9	2.0	284	20	372			1.97	3.66	0.02	1.30	26	147	102	1.25	8.3
Median	685																	
4. 1969																		
No. of Samples	10	14	14	14	14	14	14	14	13	12	13	12	11	13	5	4	3	4
Maximum	120,000	25.0	12.0	5.0	350	190	589	0.38	0.17	26.00	63.00	0.46	20.00	66	176	158	0.75	9.0
Minimum	24	0.0	4.6	0.6	160	5	211	0.03	0.01	0.07	0.53	0.00	0.02	8	136	97	0.06	8.1
Average		10.8	8.6	2.6	273	31	395	0.14	0.08	7.67	14.20	0.08	3.37	31	150	121	0.52	8.6
Median	1,000																	
5. 1970																		
No. of Samples	12	12	12	12	12	12	12	12	12	11	12	12	12	11	6	6	4	5
Maximum	63,000	23.0	11.0	4.5	320	55	448	0.31	0.16	6.30	15.00	0.15	3.40	33	180	117	3.40	8.4
Minimum	4	0.0	5.0	0.4	190	5	250	0.02	0.00	0.08	0.32	0.00	0.04	12	120	62	0.25	7.5
Average		10.3	8.0	2.3	238	19	348	0.17	0.06	1.83	4.36	0.04	1.18	25	144	96	1.96	8.1
Median																		

*BOD₅ — 5-day biochemical oxygen demand
+ KJEL — Kjeldahl nitrogen test

Table A19-47: Water Quality of Welland River Stream Mileage – PWE 12.6 Bridge Water Street Bridge, Chippawa (Flow From Niagara River To Power Canal)

	Coli-forms MF/100ml	Water Temp. °C	DO (mg/l)	BOD ₅ * (mg/l)	Tot. Solids (mg/l)	Susp. Solids (mg/l)	Turbidity (units)	Cond. 25°C (umhos/cm ³)	Tot. P as P (mg/l)	Sol. P as P (mg/l)	NH ₃ as N (mg/l)	Tot. N KJEL + (mg/l)	NO ₂ N (mg/l)	NO ₃ N (mg/l)	Chloride (mg/l)	Hardness (mg/l)	Alk. CaCO ₃ (mg/l)	Tot. Iron (mg/l)	Phenols (ppb)
1. W.Y. 1965/66																			
No. of Samples	10	10	10	10	10	10	9	7	9	9	8	10	9	9	10	3	3	3	3
Maximum	15,000	22.0	13.0	5.6	276	17	23.0	410	0.46	0.42	8.20	17.00	0.14	1.50	35	156	116	0.50	8.3
Minimum	18	0.3	7.0	1.0	144	4	1.8	314	0.02	0.00	0.00	0.30	0.00	0.00	26	120	92	0.14	8.2
Average		13.9	9.4	2.1	206	12	7.0	335	0.08	0.06	1.14	2.11	0.02	0.24	30	138	101	0.33	8.3
Median	270																		
2. W.Y. 1966/67																			
No. of Samples	14	15	15	15	15	15	15	15	14	14	13	8	13	14	15	10	11	10	11
Maximum	5,100	22.5	13.0	3.6	318	15	14.0	344	0.04	0.00	0.23	0.77	0.01	0.15	28	140	102	1.75	8.5
Minimum	48	0.0	7.0	0.5	136	2	2.5	302	0.00	0.00	0.02	0.20	0.00	0.00	25	130	95	0.13	7.3
Average		9.3	10.1	1.6	214	10	6.2	323.1	0.02	0.01	0.09	0.45	0.00	0.06	26.7	134	98	0.44	8.1
Median	287																		
3. W.Y. 1967/Dec. 68																			
No. of Samples	18	18	17	18	18	18	18	18	18	18	18	18	18	18	18	8	8	8	8
Maximum	1,300	23.0	13.0	2.4	250	46	21	338	0.45	0.41	0.45	1.96	0.01	1.00	29	142	103	1.40	8.6
Minimum	8	0.5	8.0	0.4	182	3	1.4	298	0.01	0.16	0.01	0.16	0.00	0.00	1	136	96	0.13	5.9
Average		9.4	10.1	1.2	211	15	6.9	323	0.12	0.55	0.12	0.55	0.00	0.15	25	138	100	0.54	8.1
Median	152																		
4. 1969																			
No. of Samples	10	14	14	14	14	14	14	14	14	9	14	14	13	12	14	5	5	3	5
Maximum	1,300	23.0	13.0	1.8	240	10	20	338	0.30	0.04	0.41	1.80	0.01	4.00	34	144	100	0.95	8.8
Minimum	26	0.0	7.0	0.6	180	2	1.0	308	0.01	0.00	0.03	0.17	0.00	0.01	25	127	93	0.15	8.0
Average		8.9	9.9	1.0	209	5	6.0	324	0.05	0.02	0.11	0.54	0.00	0.44	27	135	97	0.53	8.4
Median	318																		

* BOD₅ – 5-day biochemical oxygen demand
+ KJEL – Kjeldahl nitrogen test

Table A19-48: Welland River (East) (Flow from Niagara River to Chippawa Power Canal)

Sampling Point No.	Description	Date	BOD ₅ (ppm)	Total Solids (ppm)	Susp. Solids (ppm)	Turbidity in Silica Units	Coliform Count per 100 ml
PWE 11.1	Opposite golf course west of Stanley Rd.	June/59	0.9	186	6	8.1	130
		Feb/61	3.8	184		3.0	13,800
		June/62	1.6	240		3.8	24,300
		May/63	2.9	196		7.0	42,000
		Sept/63	2.2	198			41,000
PWE 11.4	Stanley Road	Feb/61	2.6	198		2.0	58
		June/62	0.6	220		1.3	3,800
		May/63	2.2	180		6.5	270
		Sept/63	1.6	186		2	1,300
PWE 12.1	Opposite Sodom Rd. west end of Chippawa	June/59	1.2	214	6	3	500
		Feb/61	1.5	154		3	3
		June/62	1.0	208		1.5	5,100
		May/63	2.4	144		5.0	290
		Sept/63	1.2	190		2	800
PWE 12.8	Bridge above mouth at Niagara River	June/59	1.5	198	44	7	1,000
		Feb/61	2.8	178		1	45
		June/62	1.1	194		1.3	600
		May/63	2.5	136		4.0	200
		Sept/63	1.2	188		2	3,800

Table A19-49: HEPC Power Canal

Sampling Point No.	Description	Date	BOD ₅ (ppm)	Total Solids (ppm)	Susp. Solids (ppm)	Turbidity in Silica Units	Coliform Count per 100 ml	Phenols (ppb)	Iron as Fe (ppm)
P 2.8	Whirlpool Road	June/59	6.6	186	20	4.0	1,200	0.0	0.36
		Feb/61	2.3	184		2.0	114		
		June/62	1.2	214		1.5	23,000		
		May/63	3.1	218		5.0	6,000		
		Mar/64	2.7			5.0	3,800		
P 3.6	Stamford Centre Road	June/59	3.6	182	12	6.5	900	2.0	0.36
		Feb/61	1.5	190		1.0	124		
		May/63	2.7	218		4.5	940		
		Mar/64	2.3			5.0	700		
P 4.3	Portage Road Bridge	June/59	1.1	168	8	6.0	800	2.0	0.36
		Feb/61	2.7	182		1.0	79		
		May/63	2.5	214		4.0	1,100		
		Mar/64	2.2			3.5	900		
P 5.4	Dorchester St. (Traffic Circle)	June/59	6.8	166	20	3.5	700	0.0	0.36
		Feb/61	2.4	186		1.0	63		
		May/63	3.0	216		6.0	320		
		Mar/64	2.9			4.0	1,200		
P 7.2	McLeod Avenue	June/59	0.9	172	4	4.3	300	3.0	0.36
		Feb/61	1.7	190		2.0	47		
		May/63	2.3	210		9.0	1,150		
		Mar/64	2.5			4.5	1,900		
P 8.8	Junction Welland R. at Michigan Central Railway	June/59	0.8	180	4	3.7	500	3.0	0.30
		Feb/61	2.5	182		1.0	84		
		June/62	1.4	228		1.7	15,000		
		May/63	3.1	196		4.0	980		
		Mar/64	2.3			4.0	1,400		

Table A19-50: Lyons Creek and Tributaries

Sampling Point No.	Description	Date	BOD ₅ (ppm)	Total Solids (ppm)	Susp. Solids (ppm)	Turbidity in Silica Units	Coliform Count per 100 ml	Phenols (ppb)	Iron as Fe (ppm)
PWEL 12.0	Lyons Cr. just above junction at bridge	June/59	2.1	204	4	22	150		
		Feb/61	2.0	226		3	1		
		June/62	1.1	222		1.8	3,000		
		May/63	2.8	240		11.5	33,000		
		Sept/63	1.0	186	2		1,600	0	0.12
PWEL 13.8	Lyons Cr. at Conc. Rd. 5 Willoughby Twp	June/59	3.8	242	12	24	50		
		Feb/61	6.0	408	54		20		
		June/62	1.9	312		13.0	150		
		May/63	2.8	364		27.0	790		
		Sept/63	1.0	280	3			3	0.60
PWELT 14.9	Tee Cr. at Conc. Rd. 6 Willoughby Township	June/59	3.7	288	18	21	100		
		Feb/61	14.0	1178	122		30		
		June/62	1.8	332		3.8	4,000		
		May/63	2.2	226		26	1,170		
		Sept/63	1.7	296	10		120		
PWEL 14.6	Lyons Cr. at Conc. Rd. 6 Willoughby Twp.	June/59	2.0	274	28	25	20		
		Feb/61	16.0	428	58		50		
		June/62	1.9	328		2.8	3,000		
		May/63	2.3	364		24	230		
		Sept/63	1.6	296	7		150	12	0.72
PWEL 16.8	Lyons Cr. at Twp. Line-Crowland-Willoughby	June/59	1.3	248	16	15	90		
		Feb/61	6.0	452	42		20		
		June/62	1.8	374		6.5	1,500		2.25
		May/63	1.4	366		2.6	310		
		Sept/63	1.3	284	2		410	2	0.36
PWEL 19.6	Lyons Cr. at Side road ½ mile below Cooks Mills	June/59	1.6	294	4	15	40		
		Feb/61	7.6	312		10	750		2.6
		June/62	5.6	318	29		9,000		
		May/63	2.3	318		2.6	90		
		Sept/63	1.9	290	4		400	9	0.9
PWEL 23.2	Lyons Cr. at Ontario Road	June/59	7.6	342	8	25	190,000		
		Feb/61	21.0	398		37	5,000		11.8
		June/62	7.0	474	28		247,000	3	4.4
		May/63	2.8	588		110	16,000,000	8	35.0
		Sept/63	6.0	246	13		>150,000	20	2.64
PWELB 24.0	Ditch downstream from Bradley St. pumping station-Welland	Sept/63	65	508	119			30	5.5
PWEL 24.2	Lyons Cr. at South St.	Sept/63	8.8	350	20		53,000	16	4.5

Table A19-51: Water Quality of Ushers Creek Stream Mileage — U 0.0 Niagara Parkway

	Coli- forms MF/100ml	Water Temp. °C	DO (mg/l)	BOD ₅ * (mg/l)	Tot. Solids (mg/l)	Turb- idity (units)	Cond. 25°C (umhos/cm ³)	Tot. P asP (mg/l)	Sol. P asP (mg/l)	NH ₃ N (mg/l)	Tot. KJEL ⁺ N (mg/l)	NO ₂ N (mg/l)	NO ₃ N (mg/l)	Chlor- ide (mg/l)	Hard- ness CaCO ₃ (mg/l)	Alk. CaCO ₃ (mg/l)	Tot. Iron (mg/l)	Phenols (ppb)	pH
1. W.Y. 1965/66																			
No. of Samples	11	11	11	11	10	10	8	11	10	10	11	10	10	11	4	4	4	4	4
Maximum	57,000	23.0	12.0	3.7	414	38	360	0.20	0.10	0.30	1.60	0.02	1.50	35	160	99	3.70	8.3	
Minimum	40	0.2	6.0	0.6	142	11	153	0.03	0.00	0.00	0.26	0.00	0.00	10	60	27	0.40	7.2	
Average	14.4	8.9	1.7	225	18	15.9	306	0.09	0.03	0.11	0.76	0.00	0.32	26	119	67	1.65	7.8	
Median	540																		
2. W.Y. 1966/67																			
No. of Samples	13	14	14	14	14	14	14	13	13	13	13	13	13	14	10	10	10	6	
Maximum	41,000	23.5	11.0	5.0	360	117	372	0.11	0.07	0.49	1.70	0.02	2.00	28	140	102	4.75	8.4	
Minimum	130	1.0	2.0	0.9	188	2	203	0.03	0.00	0.03	0.39	0.00	0.00	10	90	23	0.18	8.1	
Average	10.6	8.6	2.2	241	22	18.9	292.3	0.06	0.03	0.17	0.86	0.01	0.52	21.4	120	71	1.27	8.3	
Median	720																		
3. W.Y. 1967/Dec. 68																			
No. of Samples	18	18	18	18	18	18	18	18	18	18	18	18	18	18	8	8	8	8	
Maximum	10,800	23.0	12.0	9.0	729	454	678	0.59	3.50	0.03	1.50	0.03	1.50	30	142	101	240		
Minimum	172	0.0	0.2	0.4	176	4	232	0.01	0.14	0.00	0.14	0.00	0.00	12	60	33	0.28		
Average	9.4	7.2	1.9	264	39	24.1	334	0.21	1.14	0.01	1.14	0.01	0.21	22	119	72	1.18		
Median	465																		
4. 1969																			
No. of Samples	10	14	14	14	14	14	14	14	10	14	14	13	12	14	5	4	3	5	
Maximum	9,800	22.0	12.0	3.2	380	30	535	0.24	0.15	0.63	13.00	0.06	0.80	27	200	99	4.28	8.6	
Minimum	90	0.0	0.6	0.8	120	5	149	0.01	0.01	0.03	0.09	0.00	0.01	6	128	70	0.45	3.8	
Average	9.3	6.3	1.6	197	15	23.8	291	0.09	0.07	0.22	1.74	0.02	0.17	20	146	90	1.79	7.2	
Median	286																		

* BOD₅ — 5-day biochemical oxygen demand
+ KJEL — Kjeldahl nitrogen test

Table A19-52: Usshers Creek

Sampling Point			BOD ₅ (ppm)	Solids (ppm)			Turbidity in Silica Units	Coliform Count per 100 ml
No.	Location	Date		Total	Susp.	Diss.		
U 0.1	River Road	July/59	1.6	190			3.0	
		May/61	1.8	226			4.0	30
U 1.2	Sideroad 1¼miles above Niagara River	July/59	3.2	262	44	218		
		May/61	4.4	280	40	240		20
U 2.9	Sodom Road	July/59	4.0	330	64	266		
		May/61	5.2	280	32	248		32
Bayers Creek								
BY 0.1	Just above Niagara River	July/59	0.9	194			15.0	
		May/61	2.3	236			7.0	10
BY 0.6	First sideroad above mouth	July/59	2.8	408			115	
		May/61	6.0	380	80	300		30

Table A19-53: Water Quality of Black Creek Stream Mileage — B 0.1 Niagara Parkway

	Coli- forms MF/100ml	Water Temp. °C	DO (mg/l)	BOD ₅ * (mg/l)	Tot. Solids (mg/l)	Turb- idity (units)	Cond. 25°C (umhos/cm ³)	Tot. Sol.		NH ₃ as N (mg/l)	Tot. KJEL ⁺ (mg/l)	NO ₂ as N (mg/l)	NO ₃ as N (mg/l)	Chlor- ide (mg/l)	Hard- ness (mg/l)	Alk. CaCO ₃ (mg/l)	Tot. Iron (mg/l)	Phenols (ppb)	pH
								P as P (mg/l)	P as P (mg/l)										
1. W.Y. 1965/66																			
No. of Samples	11	11	11	11	10	10	9	11	10	10	10	10	10	11	4	4	4	4	
Maximum	6,700	24.0	12.0	3.9	352	41	53	423	0.20	0.08	0.20	1.20	0.02	0.80	36	154	100	12.2	8.3
Minimum	110	0.0	6.0	0.5	196	10	3.6	258	0.03	0.00	0.00	0.26	0.00	0.00	9	120	44	0.43	7.3
Average		15.0	8.8	1.9	236	20	18.5	339	0.09	0.03	0.07	0.74	0.00	0.18	26	132	82	3.67	7.9
Median	470																		
2. W.Y. 1966/67																			
No. of Samples	14	15	15	15	14	15	14	15	14	14	13	14	11	15	11	11	11	11	
Maximum	360,000	23.0	12.0	4.3	354	108	91	455	0.15	0.12	0.49	1.80	0.01	2.00	28	238	112	4.23	8.5
Minimum	152	0.0	7.0	0.6	178	2	4.5	306	0.01	0.00	0.03	0.20	0.00	0.00	11	116	40	0.29	7.4
Average		9.9	9.2	2.1	269	26	28.3	345	0.07	0.03	0.12	0.84	0.00	0.37	22	155	90	1.41	7.9
Median	3,950																		
3. W.Y. 1967/Dec. 68																			
No. of Samples	18	18	18	18	18	18	18	18	18	18	18	18	18	18	8	8	8	8	
Maximum	27,000	23.0	11.0	4.6	645	92	95	1010		0.90	2.10	0.06	0.81	28	276	103	2.95	8.5	
Minimum	160	0.0	4.0	0.4	198	2	4	276		0.01	0.12	0.00	0.00	10	132	43	0.32	7.3	
Average		9.6	8.1	1.7	292	27	26	411		0.25	0.92	0.01	0.22	21	171	91	1.24	8.0	
Median	1,950																		
4. 1969																			
No. of Samples	10	14	14	14	14	14	14	14	14	9	14	13	11	14	5	5	3	5	
Maximum	4,000	22.0	12.0	4.0	290	50	150	416	0.20	0.15	0.31	1.70	0.05	0.80	28	188	106	3.75	8.7
Minimum	92	0.0	5.0	0.4	170	4	2	239	0.02	0.01	0.02	0.22	0.00	0.01	6	128	65	0.60	7.4
Average		9.3	8.4	1.4	219	15	33	332	0.08	0.06	0.13	0.63	0.01	0.21	21	151	92	1.55	8.1
Median	1,220																		

* BOD₅ — 5-day biochemical oxygen demand
+ KJEL — Kjeldahl nitrogen test

Table A19-54: Black Creek

Sampling Point No.	Location	Date	BOD ₅ (ppm)	Solids (ppm)		Turbidity in Silica Units	Coliform Count per 100ml	Iron as Fe (ppm)	Colour in Hazen Units
				Total	Susp.				
BL 0.1	River road near mouth at Niagara River	July/59	8.6	228		24	<10,000		
		Aug/60	2.0			7	360		
		May/61	9.0	474	92	382	1,730		
		May/63	3.6	542		84	7,000	2.7	250
BLX 0.2	Improved watercourse	May/61	1.7	402	64	338	2,010		
		May/63	4.5	334		29	10,600	1.8	145
		July/59	9.6	312	24	288	1,000,000		
		Aug/60	5.0			78	700		
BL 1.6	Queen Elizabeth Hwy.	May/61	1.8	464	92	372	1,120		
		May/63	3.6	578		110	4,900	4.8	130
		Aug/60	5.0			70	400		
		July/61	6.0	650	122	528	1,410		110
BLB 2.5	Beaver Cr. at first sideroad above confluence with Black Creek	Apr/63					8,000		
		July/59	6.8	822	12	810	<10,000		
		Aug/60	7.0			48	31		
		June/61	0.5	724		1.0	140		
BLB 4.3	Beaver Cr. Stevensville — Bowen Road	May/63	1.4	698		2.3	2,700	0.5	140
		July/59	11.0	584	26	558	<10,000		
		May/61	1.0	652	8	644	113		
		May/63	1.4	570		2.8	3,800	0.5	65
BLB 7.3	Beaver Cr. at Old Garrison Road	July/59	2.3	2240		17	58,000		
		May/61	6.0	1136			7,000		
		May/63	1.2	1166		1.0	7,600	0.35	60
		May/63	2.8	676		31	2,700	2.8	45
BLB 7.6	Beaver Cr. conc. road between Conc. 15 & 16, Bertie Township								
BLB 8.3	Regional Road 116, ditch north of Ridgeway	Apr/62	27.0	570	282	288	70,000		
BL 3.6	Black Cr. at sideroad below junction of south branch	July/61	4.4	714	134	580	210		200

Table 19-54: Black Creek – continued

Sampling Point No.	Location	Date	BOD ₅ (ppm)	Solids (ppm)		Turbidity in Silica Units	Coliform Count per 100 ml	Iron as Fe (ppm)	Colour in Hazen Units
				Total	Susp.				
BL 3.8	Black Cr. at railway bridge below junction of south branch	Aug/60 July/61	14.0 16.0	684	96	588	700 240		200
BLS 4.0	Black Cr. south branch Conc. 10 Bertie Township	July/59 Aug/60 July/61 Aug/60 May/63	25.0 6.0 4.0 6.0 2.0	676 674	94 114	582 560	<10,000 430 480 430 7,700	2.7	260
BLS 4.8	Black Creek south branch at Bowen Road	July/59 Aug/60 May/61	11.0 14.0 7.0	2452 1392	18 18	2434 1374	<10,000 4,000 610		
BLS 8.6	Black Cr. south branch at Old Garrison Road	May/63 July/59 May/61	2.6 15.0 5.2	1342 398 330	76 62	322 268	5,000 40,000 860	1.8	110
BL 4.1	Black Cr. just above junction with south branch	May/63 Aug/60 July/61	3.2 5.0 1.6	300 714	300 140		4,100 500 260	2.2	210
BL 4.5 WS	12" drain to Black Cr. east end of Stevens-ville	Apr/62 May/63 May/61 Apr/62		480 610 592	70 48	540 544	38,000 110,000 84,000,000 600,000	3.2	215
BL 4.8 DSI	Outfall to Black Cr. S.E. Corner of Regional Road 116	July/59 Apr/62	40.0 27.0	654 732	60 42	594 690	17,000,000 1,830,000		
BL 4.8 DS3	Outfall to Black Cr. N.W. corner of Regional Road 116	May/61 Apr/62	96 580	466 1072	56 178	410 894	790,000 36,000,000		
BL 4.8 DS4	Outfall to Black Cr. S.W. corner of Regional Road 116	May/61 Apr/62	8.0 11.0	442 588	20 122	420 466	150,000 164,000		
BL 5.0 WS	Outfall to Black Cr. west end of Stevens-ville	Apr/62	30	504	56	448	1,890,000		
BL 5.5	Black Cr. first conc. north of Stevensville	July/59 Aug/60 May/61 July/61 Apr/62 May/63	18.0 12.0 11.0 2.4 5.2	530 440 506 430	52 20 58	478 420 448	<10,000 980 570 230 52 310	2.0	215

* BOD₅ – 5-day biochemical oxygen demand
+ KJEL – Kjeldahl nitrogen test

Table A 19-55: Water Quality of Baker Creek Stream Mileage -- BK 0.1 Niagara Parkway

	Coli. forms MF/100ml	Water Temp. °C	DO (mg/l)	BOD ₅ * (mg/l)	Tot. Solids (mg/l)	Turb- idity (units)	Cond. 25°C (umhos/cm ³)	Tot. P as P (mg/l)	Sol. P as P (mg/l)	NH ₃ N (mg/l)	Tot. KJEL ⁺ N (mg/l)	NO ₂ as N (mg/l)	NO ₃ as N (mg/l)	Chlor- ide (mg/l)	Hard- ness (mg/l)	Alk. CaCO ₃ (mg/l)	Tot. Iron (mg/l)	Phenols pH (ppb)
1. W.Y. 1965/66																		
No. of Samples	11	11	11	11	10	11	11	7	10	9	10	10	10	10	4	4	4	4
Maximum	1,700	23.0	12.0	2.8	274	47	36	379	0.23	0.10	0.20	0.01	0.70	46	154	101	2.22	8.0
Minimum	4	0.0	6.0	0.5	130	11	0	310	0.03	0.01	0.00	0.00	0.00	9	70	24	0.47	7.0
Average	14.6	8.1	8.1	1.6	196	18	13	327	0.08	0.04	0.09	0.65	0.00	27	118	78	1.25	7.6
Median	730																	
2. W.Y. 1966/67																		
No. of Samples	13	15	15	15	15	15	15	15	14	14	14	14	14	15	11	11	11	11
Maximum	25,000	23.5	11.0	5.6	342	108	56	446	0.32	0.08	0.56	8.30	0.01	0.60	180	111	13.50	8.7
Minimum	140	0.0	4.0	0.9	140	4	4	181	0.01	0.00	0.02	0.39	0.00	0.00	7	60	24	0.15
Average	9.5	8.1	8.1	2.2	234	29	22.9	292.9	0.08	0.04	0.17	1.43	0.00	0.12	20	124	79	2.41
Median	560																	7.9
3. W.Y. 1967/Dec. 68																		
No. of Samples	17	17	17	17	17	17	17	17		17	17	17	17	17	8	8	8	8
Maximum	4,600	23.0	11.0	5.4	568	116	74	666		1.70	1.90	0.03	0.20	28	142	104	4.45	8.4
Minimum	28	0.0	2.2	0.7	166	4	2.8	176		0.01	0.27	0.00	0.00	1	84	39	0.30	7.2
Average	9.6	7.5	7.5	2.2	231	24	24.3	306		0.27	1.00	0.01	0.05	17	123	77	1.62	7.9
Median	370																	
4. 1969																		
No. of Samples	10	13	14	14	14	14	14	14	9	14	14	13	12	14	5	5	3	5
Maximum	2,400	23.0	12.0	3.5	290	60	84	383	0.21	0.08	0.60	1.50	0.02	0.25	31	172	105	5.75
Minimum	88	0.0	0.6	0.8	140	5	2	161	0.02	0.01	0.01	0.19	0.00	0.01	7	129	38	0.40
Average	10.1	6.7	6.7	1.5	212	23	20.6	295	0.08	0.04	0.18	0.69	0.01	0.06	20	141	87	2.45
Median	330																	7.9

* BOD₅ -- 5-day biochemical oxygen demand
+ KJEL -- Kjeldahl nitrogen test

Table A19-56: Baker Creek

Sampling Point			BOD ₅	Solids (ppm)			Turbidity in Silica	Coliform Count
No.	Location	Date	(ppm)	Total	Susp.	Diss.	Units	per 100 ml.
BK 0.1	River Road	July/59	0.9	208	—	—	16	—
		May/61	5.6	228	40	188	—	370
BK 0.4	Road 0.4 Miles from mouth.	July/59	1.8	204	—	—	23	—
		May/61	3.0	204	24	180	—	20
Miller Creek								
MI 0.1	River Road	July/59	1.6	190	—	—	10	—
		June/61	5.0	342			6.0	350
MI 0.5	Road ½ mile above mouth.	July/59	3.8	360			91	—
		June/61	2.0	920			17	450
Frenchman Creek								
F. 0.1	River Road	June/59	3.4	432	8	424	18	3,400
		Aug/60	2.1				6	50
		May/61	2.8	828			18	20
F 1.8	Road south of golf course	June/59	4.9	502	12	490	13	152
		Aug/60	1.9				8	17,000
		May/61	4.0	486			5	300
F 2.5	Conc. Rd. 2 Bertie Twp.	June/59	7.4	276	34	242	18	0
		Aug/60	4.1				13	510
		May/61	3.6	314			7	17
F 3.9	Queen Elizabeth Hwy.	June/59	3.4	340	32	308	82	150
		May/61	2.8	314			7.0	190

Table A19-57: Water Quality of Miller Creek Stream Mileage — M 0.1 Niagara Parkway

	Coli- forms MF/100ml	Water Temp. °C	DO (mg/l)	BOD ₅ * (mg/l)	Tot. Solids (mg/l)	Turb- idity (units)	Cond. 25°C (umhos/cm ²)	Tot. P		NH ₃ N		NO ₂ as N		NO ₃ as N		Chlor- ide (mg/l)	Hard- ness (mg/l)	Alk. CaCO ₃ (mg/l)	Tot. Iron (mg/l)	Phenols (ppb)
								as P	as P	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)					
1. W.Y. 1965/66																				
No. of Samples	11	11	11	11	10	11	11	8	10	10	10	9	10	10	11	4	4	4	4	4
Maximum	11,000	23.5	13.0	3.0	510	65	56	706	0.20	0.07	0.38	1.10	0.03	0.34	40	300	125	2.26	8.1	8.1
Minimum	12	0.0	7.0	0.8	196	6	3.6	318	0.02	0.00	0.00	0.40	0.00	0.00	26	128	93	0.40	7.5	7.5
Average		14.3	8.9	1.8	286	19	17	418	0.08	0.03	0.13	0.64	0.01	0.08	31	201	106	1.24	7.8	7.8
Median	410																			
2. W.Y. 1966/67																				
No. of Samples	14	15	15	15	15	15	15	15	14	14	14	14	14	14	14	10	10	10	10	10
Maximum	42,000	24.0	12.0	8.0	782	228	84	983	0.20	0.07	0.33	2.10	0.01	2.00	52	470	130	8.60	8.5	8.5
Minimum	92	0.0	8.0	0.8	190	7	5	304	0.00	0.00	0.03	0.26	0.00	0.00	17	130	58	0.23	7.4	7.4
Average		9.7	9.5	2.2	345	35	26	457	0.05	0.03	0.09	0.85	0.00	0.27	30	212	103	2.03	8.0	8.0
Median	2,150																			
3. W.Y. 1967/Dec. 68																				
No. of Samples	18	18	18	18	18	18	18	18				18	18	18	18	8	8	8	8	8
Maximum	19,000	23.0	12.0	4.8	1702	120	91	2060				0.80	1.65	0.04	0.92	114	594	162	6.20	8.4
Minimum	0	0.0	6.0	0.7	188	3	2.5	250				0.02	0.18	0.00	0.00	11	138	62	0.43	7.3
Average		9.3	8.3	1.7	479	27	24.5	624				0.23	0.71	0.01	0.19	38	230	106	1.67	8.0
Median	425																			
4. 1969																				
No. of Samples	10	14	14	14	14	14	14	14	14	10	14	14	13	11	14	5	5	3	5	5
Maximum	630.00	23.0	12.0	4.0	1650	50	91	1970	0.18	0.06	0.40	1.30	0.02	0.42	113	1064	220	1.10	8.7	8.7
Minimum	70	0.0	4.8	0.6	180	2	3	314	0.01	0.00	0.02	0.18	0.00	0.01	25	134	87	0.50	7.4	7.4
Average		9.5	8.5	1.4	377	15	17.8	539	0.06	0.03	0.11	0.61	0.01	0.13	36	345	120	0.74	8.1	8.1
Median	860																			

* BOD₅ — 5-day biochemical oxygen demand
+ KJEL — Kjeldahl nitrogen test

Table A19-58: Water Quality of Frenchman Creek Stream Mileage – FR 0.0 Niagara Parkway

	Coli- forms MF/100ml	Water Temp. °C	DO (mg/l)	BOD ₅ * (mg/l)	Tot. Solids (mg/l)	Turb- idity (units)	Cond. 25°C (umhos/cm ³)	Tot. P (mg/l)	Sol. P as P (mg/l)	NH ₃ N (mg/l)	Tot. KjEL ⁺ (mg/l)	NO ₂ as N (mg/l)	NO ₃ as N (mg/l)	Chlor- ide (mg/l)	Hard- ness (mg/l)	Alk. CaCO ₃ (mg/l)	Tot. Iron (mg/l)	Phenols (ppb)
1. W. Y. 1965/66																		
No. of Samples	11	11	11	11	10	11	9	7	11	10	9	11	10	10	4	3	4	4
Maximum	5,000	27.0	12.0	5.1	1326	62	39	1470	0.20	0.08	0.23	1.60	0.15	0.80	62	412	145	2.45
Minimum	56	0.0	6.0	1.0	188	3	1.5	324	0.01	0.00	0.00	0.26	0.00	0.00	28	132	100	0.25
Average		14.9	9.1	1.9	544	21	16.4	654	0.08	0.03	0.09	0.75	0.02	0.25	37	258	118	1.06
Median	800																	7.9
2. W. Y. 1966/67																		
No. of Samples	13	15	15	15	15	14	14	15	14	14	14	14	14	13	3	10	10	10
Maximum	34,000	24.0	11.0	10.0	1036	104	200	1261	0.14	0.06	0.58	1.50	0.02	1.20	54	278	176	9.20
Minimum	70	0.0	7.0	0.4	226	7	1.5	330	0.01	0.00	0.03	0.26	0.00	0.00	9	140	87	0.11
Average		10.1	9.3	2.5	472	23	33.8	599	0.06	0.02	0.14	0.72	0.00	0.34	30	199	119	1.59
Median	390																	8.1
3. W. Y. 1967/Dec. 68																		
No. of Samples	18	18	17	18	18	18	17	18		18	18	18	18	18	8	8	8	8
Maximum	21,000	23.0	10.0	10.0	1434	75	91	1725		0.54	1.65	0.05	0.72	60	480	167	2.05	8.5
Minimum	16	0.0	1.0	0.8	210	4	2.3	310		0.03	0.18	0.00	0.00	1	152	86	0.16	7.3
Average		10.7	7.0	2.3	498	21	22.9	659		0.21	0.74	0.01	0.31	30	266	121	0.88	8.0
Median	790																	
4. 1969																		
No. of Samples	10	14	14	14	14	14	13	14	14	9	14	14	13	12	5	5	2	5
Maximum	109,000	23.0	12.0	5.0	700	50	25	928	0.18	0.08	0.62	1.40	0.04	1.30	42	476	148	0.36
Minimum	100	0.0	6.0	0.6	180	2	3	313	0.01	0.00	0.01	0.18	0.00	0.01	14	140	97	0.15
Average		9.5	9.0	1.6	307	12	19.2	461	0.05	0.03	0.14	0.57	0.01	0.28	27	216	109	0.25
Median	930																	8.2

* BOD₅ – 5-day biochemical oxygen demand
+ KjEL – Kjeldahl nitrogen test

Table A19-59: Water Quality of Water Courses Discharging into Lake Erie

Sampling Point and No.	Date	BOD ₅ (mg/1)	Solids		ABS (mg/1)	Coliforms per 100 ml
			Total (mg/1)	Susp. (mg/1)		
A Town of Fort Erie						
1 Culvert at Radford St. near Dominion Rd.	July/Aug 68	7.2		3	1.7	2,300,000
2 Ditch at 52 Queens Blvd. near George St.	Jul/Aug 68	110.0		278	42.0	8,600,000
3 Albert St. Storm Sewer	Jul 59	37.0	378	74		10,000,000
	Apr 62	57.0	416	46		150,000
4 Bardol Ave. Storm Sewer at 42 Bardol Ave. (Ditch)	Apr 62	5.4	212	8		9,000
	Jul/Aug 68	66.0		45	6.8	26,000,000
		30.0		33	3.7	
5 Outfall from tank	Apr 62	6.0	280	12		15,000
6 Helena St. Storm Sewer	Apr 62	5.6	362	20		6,700
7 Ditch at Edgemere & Beach View	July/Aug 68	155.0		51	2.8	3,500,000
8 Beachview Ave. Storm Sewer	Apr 62	12.0	348	44		150,000
9 Ditch at Edgemere & Rose Rd.	July/Aug 68	52.0		42	5.9	9,000,000
10 Ditch at Kraft & Edgemere	Jul/Aug 68	7.6		93	0.7	1,030,000
11 Ditch at 1103 Edgemere	Jul/Aug 68	1.0			0.1	3,300
12 Ditch east of Crescent Rd.	Apr 62	3.6	296	26		900
13 Crescent Rd. Ditch	Jul/Aug 68	40.0		62	16.3	11,000,000
14 Ditch at 29 Kam Rd.	Apr 62	13.0	288	38		187,000
		10.0		36	1.8	1,500,000
15 Buffalo Rd. drain at Lake	Jul/Aug 68					30,000*
16 Ditch at Jamboree Drive-In	Jul/Aug 68	1.0		44	0.1	300,000
17 Ditch between Rosehill & Bertie Bay Rd.	Jul/Aug 68					250,000*
18 Bertie Bay Rd. drain	Jul/Aug 68	3.6		34	0.6	2,500,000
19 Windmill Point at Mott's Place	Jul/Aug 68					5,300*
20 Ditch at Windmill Point East	Jul/Aug 68	7.0			0.0	6,500
21 Drain at Schintzius in Stanland Park	Jul/Aug 68					8,000,000*
22 Drain at Connelly — Windmill Point	Jul/Aug 68					5,500*
23 Bardol at Windmill Point	Jul/Aug 68					80,000,000*
24 Drain at Ernst (Steel Culvert)	Jul/Aug 68	7.0		32	0.0	8,000,000
25 Concrete Culvert at Ernst	Jul/Aug 68					8,000,000*
26 Six Mile Creek						
a) at Lake (0.1 mi)	Jul 59	2.5	254	24		40
	May 61	2.6	270	18		30
	Jul/Aug 68					3,600
b) at Thunder Bay Drain (0.6 mi)	May 61	2.8	360	18		350
	Jul/Aug 68	2.2			0.1	830
c) at Hwy. 3C (1.0 mi)	Jul 59	12.0	366	44		100
	May 61	4.4	338	8		30
d) at Mann Drain (1.7 mi)	May 61	5.3	296	16		
	Apr 62	Oily Material Present				
e) Mann Drain at Prospect Pt. Rd.	May 61	4.2	304	24		42
	Apr 62	61.0	830	384		52,000
	Jul/Aug 68	64.0		52	18.0	210,000,000
f) Mann Drain at Burleigh Rd.	Jul/Aug 68	504.0		20	0.7	680,000

Table A19-59: Water Courses Discharging into Lake Erie – *continued*

Sampling Point and No.	Date	BOD5 (mg/1)	Solids		ABS (mg/1)	Coliforms per 100 ml
			Total (mg/1)	Susp. (mg/1)		
27 Ridgeway – Prospect Pt. Rd. Ditch						
a) north of Hazel St.	Apr 62	25.0	294	24		212,000
b) at Hibbard St.	Apr 62	7.6	366	22		160,000
c) ditch at Cutler St.	Apr 62	82.0	432	66		2,600,000
d) ditch at Hwy. 3C	Apr 62	360	652	48		2,700,000
28 Small Ditch at Thunder Bay	Jul/Aug 68					80,000*
29 Small Ditch at Burleigh Rd.	Jul/Aug 68					4,700,000*
30 Effluent Crystal Beach WPCP.	Jul/Aug 68	0.8		5	0.0	8,000,000
31 Dimmick Drain at Beach	Jul/Aug 68	50.0		135	1.2	3,100
32 Coatsworth Drain	Jul/Aug 68					4,200*
33 Ditch at Fisher – Point Abino Road	Jul/Aug 68	130 65		72 658	3.7 0.3	2,700,000
34 Ditch at Abino Hills (Marsh Drain)	Jul/Aug 68					5,400*
35 Ditch at Point Abino (Private)	Jul/Aug 68					14,000*
B – City of Port Colborne						
50 Ditch at Cedar Bay Ave.	May 61	4.0	230	22		115
51 Ditch at Weaver Rd.	Jul 59	6.0	342	18		10
	May 61	16.0	314	40		60
52 Ditch at Snider Rd.	Jul 59	9.0	342	16		10
	May 61	4.0	376	36		237
53 Stream at mouth of Welland Canal	Jun 59	5.2	258	42		
54 Storm Sewer at Elm St.	Jun 59	2.6	508	14		10,000
	May 61	3.6	278	14		27
55 Ditch Sugarload St. – Rosemount Ave.	Jun 59	74.0	732	210		90,000
	May 61	4.8	554	48		299
56 Ditch Outlet at Rosemount Ave.	Jun 59	3.0	472	12		40,000
	May 61	14.0	536	10		27
57 Drain From Canada Cement Co. Ltd.	Jun 59	10.0	470	34		10,000
	May 61	2.5	500	6		2,900
58 Eagle Marsh Drain at Lakeshore Rd.	Jun 59	14.0	388	52		10,000
	May 61	5.6	504	132		10
59 Storm Drain from INCO	Jun 6/59		1786	180		
	Jun 29	9.4	920	24		10,000
C – Township of Wainfleet						
80 Long Beach Area Storm Sewer	Jul 59	14.0	254	16		1,000,900
	May 61	4.4	316	56		10

*Samples taken by the Niagara District Health Unit

PART FIVE

PRESENT AND FUTURE NEEDS AND POTENTIAL FOR WATER AND LAND RESOURCE DEVELOPMENT

Section A21

NEEDS AND REMEDIAL MEASURES

3. Water Supply

a. Pipeline for the Town of Niagara-on-the-Lake

Several pipeline schemes were studied to convey water from the Welland Canal along Highway 8 to St. Davids and eastward.

The objective of this scheme is to provide water for water supply, pollution abatement, flow augmentation and irrigation for the area.

Table A21-2 shows the anticipated water requirements of the area up to the year 2010. The water supply and the pollution abatement flows are based on the Servicing Master Plan of the Regional Municipality of Niagara Interim Report. The water demands are the anticipated maximum day flows for the Water District 3.

The seasonal irrigation requirements for One Mile, Two Mile, Four Mile and Eight Mile Creeks are based on the water taking permits issued by the OWRC. The water taking permits allow a maximum rate of about 6,000 g.p.m.* or 16 c.f.s. For the years 1980 to 2010 a flow rate of 9,000 g.p.m. or 24 c.f.s. has been assumed considering a 50 per cent increase due to the unrestricted availability of water and increased crop production. Table 7 of the 1964 Niagara Peninsula Report (Water Section) showed for the period from 1936 to 1958 an average water deficit of 4.47 inches for shallow rooted crops and 0.49 inches for deep rooted trees per season. The maximum deficits occurred in 1936 with deficits of 8.77 and 3.44 inches for shallow rooted crops and deep rooted trees respectively, followed by the year 1949 with deficits of 7.59 and 2.27 inches.

Surface water quality data taken by the OWRC indicate that the One Mile, Two Mile, Four Mile, Six Mile and Eight Mile Creeks are polluted with respect to coliform counts and BOD concentrations. Flow augmentation will improve and eventually help to eliminate the stream pollution.

Three schemes were investigated:

- A. seasonal water supply from April 1 to December 15 for pollution abatement, flow augmentation and irrigation;
- B. continuous water supply for water supply with recharging of existing wells at St. Davids, pollution abatement, flow augmentation and irrigation and
- C. continuous water supply for water supply with treatment plant at St. Davids, pollution abatement, flow augmentation and irrigation.

It is recommended that the servicing proposal under scheme C be further investigated taking into consideration the development intentions of the region and the over-all economics of the various alternatives.

Scheme C consists of a 9.0-mile pipeline from the Welland Canal upstream of the guard gate at the Ontario Paper Co. Ltd., to the upper reaches of Two Mile Creek (east of St. Davids).

Table A 21-1 shows the flows and the sizes of the pipeline sections with discharges into Eight Mile, Six Mile, Four Mile and Two Mile Creeks.

Scheme C differs from Scheme B in that water supply for the Town of Niagara-on-the-Lake uses surface water (canal water) with a treatment plant at St. Davids. This eliminates the 1.1-mile-long pipeline to the well fields and water can be guaranteed beyond the year 2010, which is not possible with recharging of the wells.

* gallons per minute.

The Servicing Master Plan states:

1. "It is not known whether the recharge system will provide an efficient and practical method of supply. This can only be proved through operation and this is recommended starting immediately."
2. "At sometime it may be desirable to supply water to Niagara-on-the-Lake from the St. Catharines system, and the system displayed on Plate 7,* although initially supplied from the recharge well field, is adaptable to a supply from St. Catharines."

Supplying untreated water to St. Davids from the Welland Canal, as recommended in Scheme C, instead of conveying treated water from the De Cew Filtration Plant in St. Catharines has the advantage that the untreated water in the gravity pipeline can be also economically used for flow augmentation, pollution abatement and irrigation. This multiple-use should more than offset the anticipated higher unit treatment costs at St. Davids than at St. Catharines due to the smaller plant size.

The pipe sizes are considerably less than in Scheme B as no water is supplied by gravity to the well field at elevation 490 (C.G.D.) but to a treatment site in the vicinity of St. Davids at about elevation 390. The estimated savings in pipeline construction are about \$384,000.

Dilution water for pollution abatement is available at all times. Therefore local waste treatment is possible at St. Davids and the estimated construction costs of \$263,000 for connecting to the Niagara Falls Sewage System can be used for building a local treatment plant at St. Davids.

To utilize the already installed 12- and 16-inch forcemain from the Power Canal to the well fields south of St. Davids it is recommended to use the pipeline for connecting the Niagara Falls Water Supply System with the future Niagara-on-the-Lake System. Connecting the two systems will have these advantages:

1. increased safety in the event of power or mechanical failures and
2. supplementary water supply from the Niagara-on-the-Lake WTP at St. Davids to the northern part of Niagara Falls and Stamford during times of peak demands and low pressure as the Niagara Falls WTP is located on the south side of the City at Chippawa.

The proposed pipeline can supply annually about 30,000 ac. ft. or 8.2 billion gallons of water for a capital cost of about \$1,380,000 or about \$45.5/ac. ft.+ or 16.5 cents per 1,000 gallons.

Table A21-1: Pipeline for the Town of Niagara-on-the-Lake For Water Supply (Treatment Plant), Pollution Abatement and Irrigation (Flows Will Meet The Anticipated Requirements For The Year 2010)

Location No.	Location	Length (mi)	Flow (c.f.s.)	Pipe Size (in)	Estimated Construction Costs(\$)
	Welland Canal Water Level				
1	Welland Canal at Guard Gate (0.0 mi.) to Eight Mile Creek (3.5 mi.)	3.5	42.0	36	665,000
2	Eight Mile Creek (3.5 mi.) to Six Mile Creek (4.9 mi.)	1.4	35.1	30	220,000
3	Six Mile Creek (4.9 mi.) to Trib. 'A' of Four Mile Creek (6.4 mi.)	1.5	33.1	30	235,000
4	Trib. 'A' of Four Mile Creek (6.4 mi.) to Four Mile Creek (St. Davids) (7.3 mi.)	0.9	26.8	30	145,000
5	Four Mile Creek (St. Davids) (7.3 mi.) to Two Mile Creek (8.0 mi.)	0.7	5.2	14	52,000
6	Two Mile Creek (8.0 mi.) to Trib. 'A' of Two Mile Creek (9.0 mi.)	1.0	2.2	12	64,000
	Total	9.0			1,381,000

* The Regional Municipality of Niagara, Servicing Master Plan, Plate 7, Town of Niagara-on-the-Lake.

+ \$45.50 per acre foot.

Table A21-2: Town of Niagara-on the-Lake Water Requirements in c.f.s.

	1971	1980	1990	2010
Irrigation	16.0	24.0	24.0	24.0
Water Supply (Max. Day) For Water District 3	2.4	7.0	8.9	13.5
Pollution Abatement (Dilution Water)				
For St. Davids and Queenston	2.0	2.5	3.1	4.4
	20.4	33.5	36.0	41.9

b. Pipeline for Vineland-Jordan (Town of Lincoln)

A pipeline scheme has been studied to convey water from Gibson Lake, or the holding ponds of the St. Catharines Waterworks, to Jordan. The line can provide water for water supply, pollution abatement, flow augmentation and irrigation.

Table A21-3 shows the anticipated water requirements along the pipeline up to the year 2000.

The water supply flows are based on the Servicing Master Plan of the Regional Municipality of Niagara.

The seasonal irrigation requirements for Twelve Mile, Fifteen Mile and Sixteen Mile Creeks are based on the water taking permits issued by the OWRC. The water taking permits allow a maximum rate of about 5,300 g.p.m. or 14.2 c.f.s. No increase has been considered for the period up to the year 2000.

The surface water quality data taken by the OWRC indicate that the streams in the area of the pipeline are polluted with respect to coliform-counts and BOD concentrations. Flow augmentation will improve or even eliminate the stream pollution.

The scheme consists of a 7.6-mile pipeline from the area of Gibson Lake to Jordan. Table A21-4 shows the flows and the sizes of the pipeline sections with discharges to tributaries of the Twelve Mile, Fifteen and Sixteen Mile Creeks.

The water supply for Vineland-Jordan is based on a water treatment plant at Jordan in the vicinity of Highway 8.

Supplying untreated water to Vineland-Jordan by gravity from Gibson Lake instead of conveying treated water from the St. Catharines System has several advantages.

1. The untreated water can also be used for flow augmentation, pollution abatement and irrigation.
2. The multiple-water use will more than offset the anticipated higher unit treatment costs at Jordan compared to St. Catharines due to the smaller plant size.

The estimated construction costs for the 7.6-mile pipeline are about \$837,000 and the unit costs are about \$64.5/ac. ft. or \$235/m.g.*

The installation of the Vineland-Jordan Pipeline would require changes to the Servicing Master Plan of the Regional Municipality of Niagara.

With respect to water supply the Vineland-Jordan Treatment Plant could be abandoned in the near future and therefore the estimated \$70,000 to upgrade the plant and construct the \$200,000, 3-mile-12-inch connection to St. Catharines would not be required. Other savings would be possible in treatment plant space and costs at the St. Catharines WTP and in reducing the size of the St. Catharines watermain feeding into the 12-inch connection to Jordan.

With the water treatment plant at Jordan and the abandoning of the Vineland-Jordan Plant at Lake Ontario it becomes feasible to discharge the sewage and wastes from Vine-

* million gallons

land-Jordan into Lake Ontario at Vineland. The water pollution control plant could be installed at the site of the water treatment plant using the 700 feet of 12-inch water intake as a sewer outfall.

In doing so it will not be necessary to pump the sewage to Beamsville and therefore the proposed Victoria Street Sewage Pumping Station, estimated at \$110,000, and the 21,100 feet of 14-inch forcemain, estimated at \$301,000, are not required. In addition the capacities of the sewage pumping station in Beamsville and the forcemain to Grimsby could be reduced.

Therefore, the following projects of the Servicing Master Plan would not be needed:

Water

1. Updating of Vineland-Jordan WTP (Plant to be abandoned after 1980)	—	\$ 70,000
2. 12-inch connection to St. Catharines	—	200,000
		<u>\$270,000</u>

Sewage

1. Victoria Avenue-Green Lane Road Pumping Station (1973)	—	\$110,000
2. 14-inch forcemain from Victoria Avenue to Ontario Street Beamsville (1974)	—	301,000
3. Reductions to Ontario Street Pumping Station as peak pumping rate is reduced from 3,250 to 2,400 g.p.m. (1972)	—	35,000
4. Reduction of 20-inch forcemain to 18-inch between Ontario Street and Bartlett Street — Grimsby (1973)	—	30,000

\$476,000

In addition to the above projects, the capital and operating costs of providing the water treatment facilities for the water requirements of Vineland-Jordan at the St. Catharines De Cew WTP must be compared with the costs of treatment facilities at Vineland-Jordan, as well as the costs of treating the water from Vineland-Jordan at the Grimsby STP or directly in Vineland-Jordan.

Further, the tangible and intangible benefits of the pipeline with respect to irrigation and low flow augmentation to meet satisfactory water quality objectives must be assessed.

For water supply only, a 12-inch pipeline with a capacity of 1.5 m.g.d.* would be sufficient to serve Vineland-Jordan. The estimated cost of the 12-inch pipeline would be about \$500,000 or about \$387,000 less than the proposed multi-purpose pipeline.

The proposed pipeline can supply annually about 13,000 ac. ft. or 3.5 billion gallons of water for a capital cost of about \$837,000 or 23.5 cents per 1,000 gallons.

If so desired a branch line can be built to the Rockway Falls for recreational purposes. A sizeable flow could be maintained over the scenic falls. Without irrigational water takings, water can be delivered to the lower fall without pumping. During the irrigation season a booster pumping station at the branch to Rockway Falls would be required.

It is recommended that this servicing proposal be further investigated taking into consideration the development intentions of the region and the over-all economics of supplying water for these multi-purposes.

* million gallons per day



Upper falls at Rockway, Lot 10, Concession VIII, Louth Township. The scenic beauty and recreational value of this site could be enhanced by providing flow of water over the falls during drought periods.



Disused Feeder Canal at Wainfleet looking upstream toward Port Maitland. Heavy vegetation and shallow, stagnant water is due to the lack of flow. Dredging is recommended.

Disused lock and control structure on the Old Feeder Canal, opposite the Electric Reduction Company at Port Maitland.



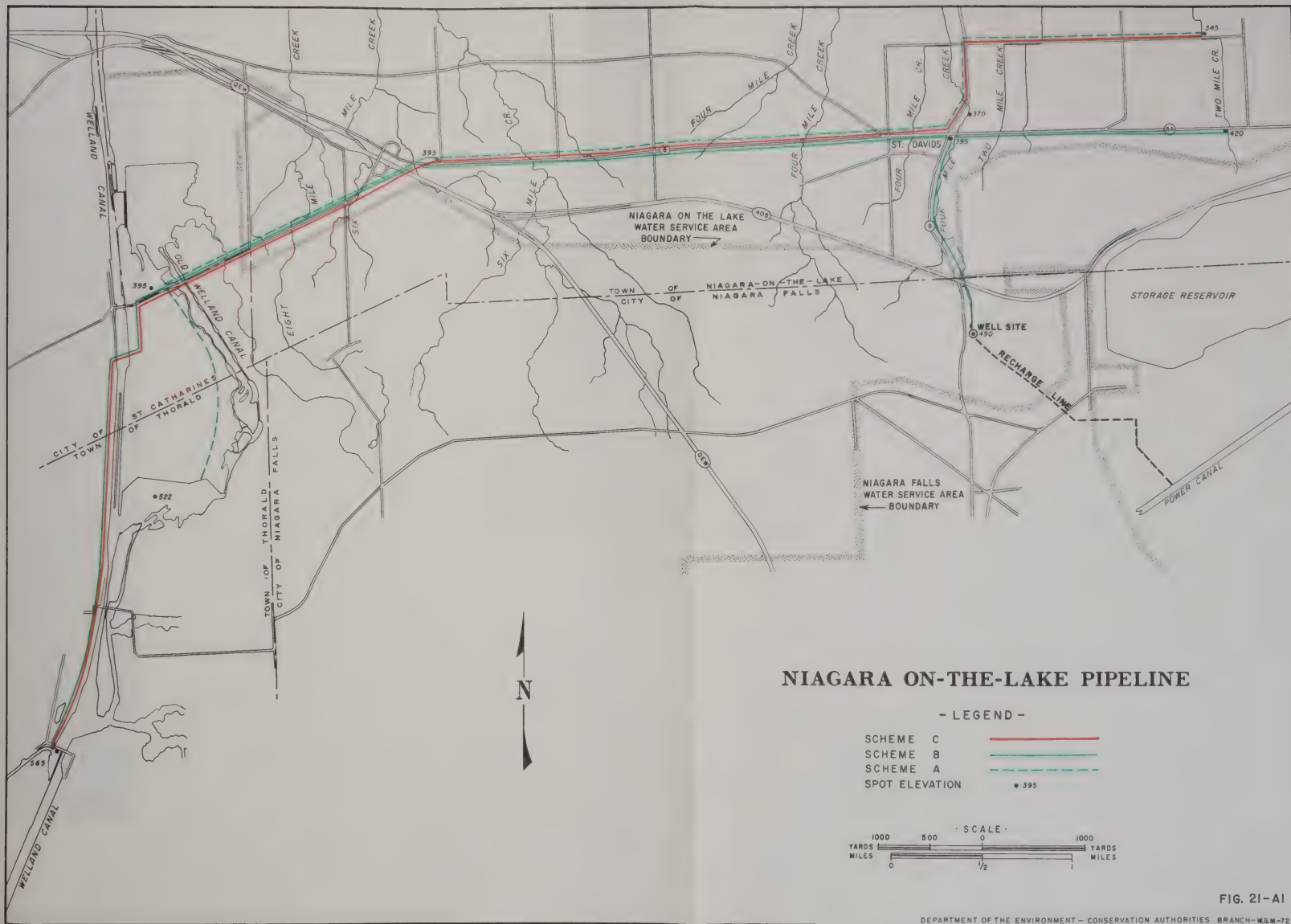


FIG. 21-A1

VINELAND - JORDAN PIPELINE

LEGEND

PROPOSED ROUTE —————
 ALTERNATE ROUTE - - - - -
 SPOT ELEVATION • 378

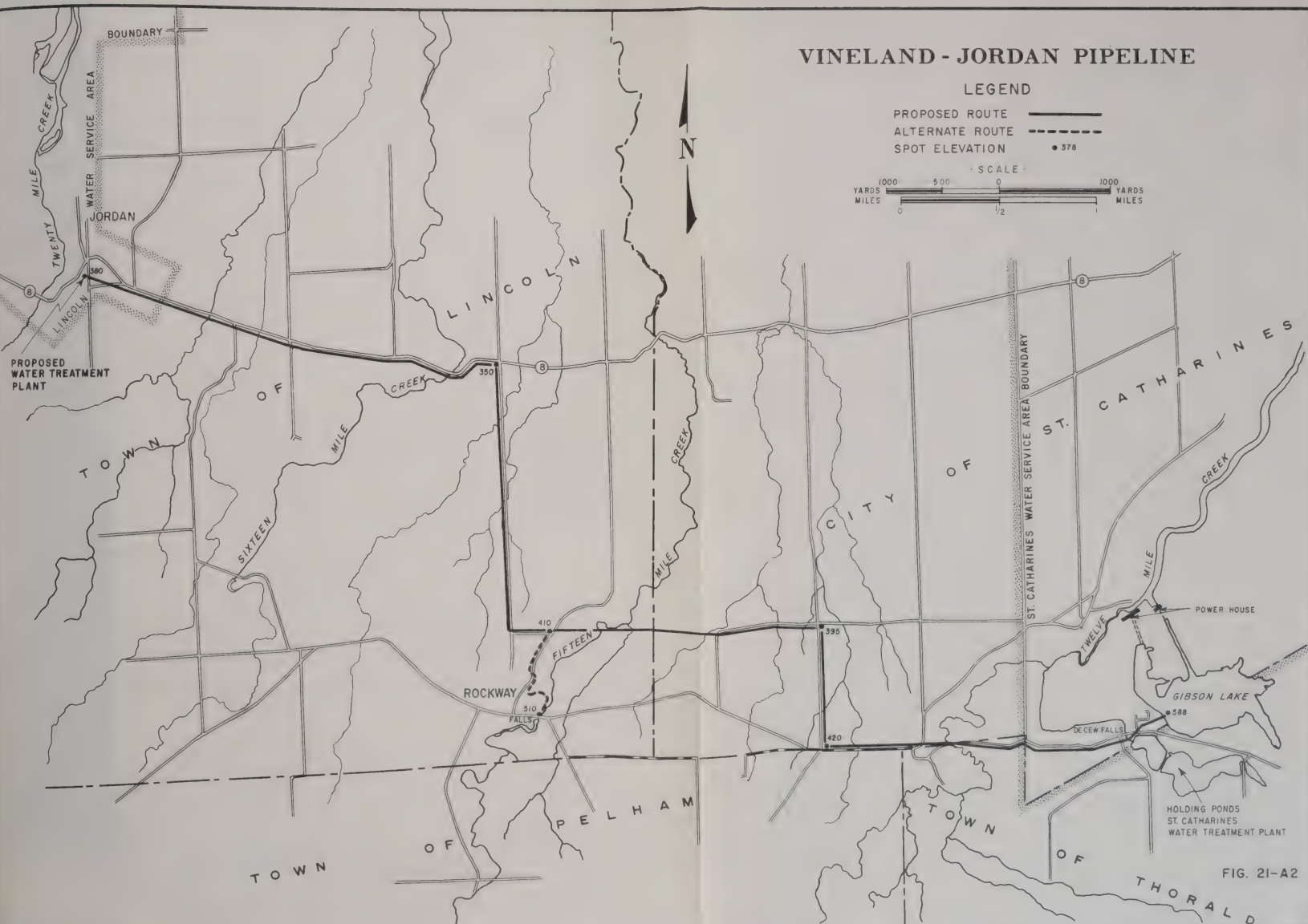
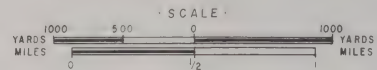
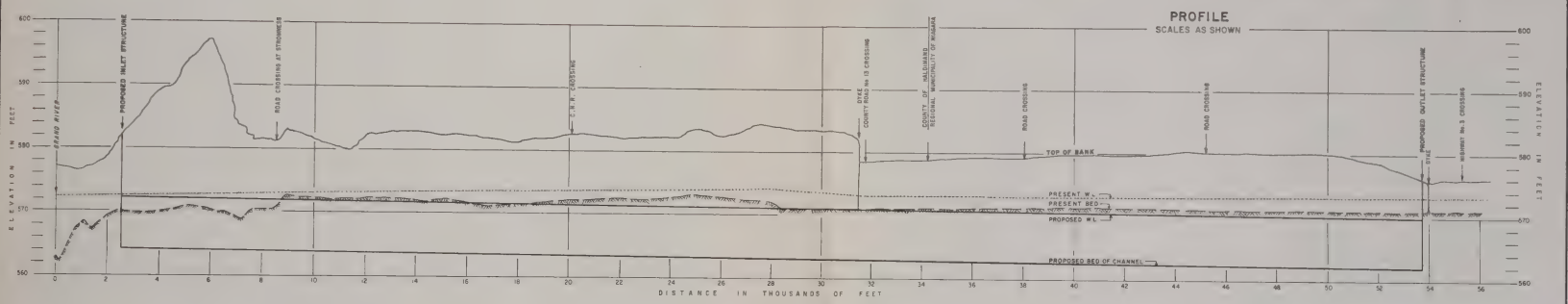
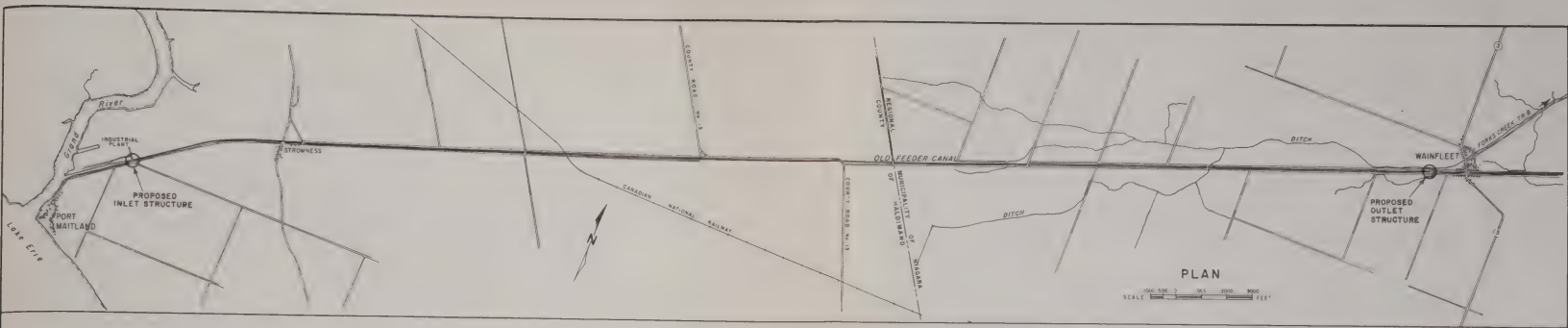
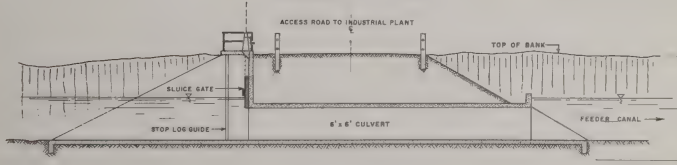


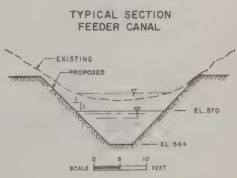
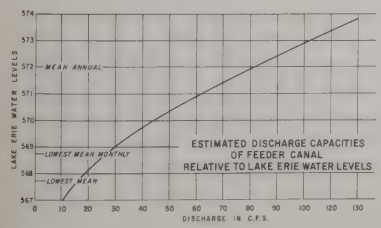
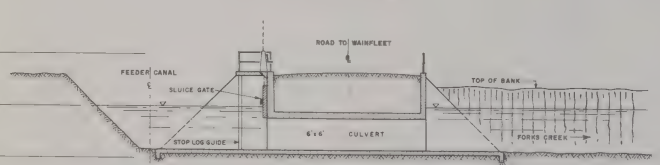
FIG. 21-A2



-SECTION-
PROPOSED INLET STRUCTURE



-SECTION-
PROPOSED OUTLET STRUCTURE



PROPOSED REHABILITATION OF OLD FEEDER CANAL

(FROM PORT MAITLAND TO WAINFLEET)

SCALES AS SHOWN

Table A21-3: Vineland - Jordan Pipeline Water Requirements in CFS

	1971	1980	1990	2000
Irrigation	14.2	14.2	14.2	14.2
Water Supply (Max. Day) For Vineland-Jordan	0.8	0.8	1.1	1.9
	15.0	15.0	15.3	16.1

Table A21-4: Niagara Peninsula Conservation Authority Gibson Lake Pipeline — Scheme 'C'

Section No.	Location	Length (mi.)	Flow (c.f.s.)	Pipe Size (in.)	Estimated Construction Cost (\$)
1	Gibson Lake				
2	West Tributary of Twelve Mile Creek (1.63 mi.)	1.63	18	30	\$258,192
3	Most Westerly Tributary of Twelve Mile Creek (3.0 mi.)	1.37	15	24	173,606
4	Fifteen Mile Creek Downstream of Rockway Falls (3.8 mi.)	0.8	12	20	84,480
5	Sixteen Mile Creek at Highway 8 (5.7 mi.)	1.9	8	16	160,512
6	Tributary of Lake Ontario west of Sixteen Mile Creek at Highway 8 (6.9 mi.)	1.2	6	16	101,376
7	Jordan, South of Highway 8 and Regional Road 575 (7.6 mi.)	0.7	3.5	16	59,136
		7.60			837,302

c. Rehabilitation of Disused Feeder Canal

A study was made of the possible rehabilitation of the disused Feeder Canal from Lake Erie (Port Maitland) to Wainfleet.

The length of this section is about 11.0 miles. The re-opening of the canal requires some dredging, the removal of some causeways, the installation of culverts in the others, and a controlled outlet at Wainfleet (see Fig. 21-A3).

At Wainfleet the water would be discharged into the Wainfleet Branch of Forks Creek. Gravity flow in the Feeder Canal would be possible as the mean water level of Lake Erie is 571.2 and the invert elevation of the Forks Creek at Wainfleet is about 563. A slope of 0.2 ft./mile has been assumed for the canal invert.

With a Lake Erie water level of 571.2 and a canal invert elevation of 569 and 568 the respective flows in the canal would be about 42 and 77 c.f.s. For a canal invert elevation of 566.5 the flow would be about 120 c.f.s.

The estimated project costs for the three alternatives vary from \$384,000 to \$780,000 or based on unit costs from \$12.50 to \$8.90 per ac.ft. of water per year.

The rehabilitation of the canal provides several benefits.

1. Flow augmentation and pollution abatement for the Forks Creek and Welland River. A municipal sewerage system would become possible for Wainfleet.
2. Water supply for Wainfleet either by direct treatment or recharge becomes an alternative to the existing ground water supply.
3. Better drainage can be provided in the spring by pumping water from the numerous drainage ditches into the Feeder Canal.
4. Irrigation water can be provided in the summer for cash crops, etc.

It is recommended that this proposal be further investigated taking into account the fluctuations in Lake Erie levels and how this might affect the various proposed water uses.

9. Fish and Wildlife Developments

a. Fish

i. Twelve Mile Creek

It is recommended that the Conservation Authority make a definite effort to persuade owners of property through which flow the Twelve Mile Creek and its permanent tributaries to improve their streams for brook trout by the methods described in detail in *Upper Welland River and Twelve Mile Creek Biology Study*, published by the Department of Energy and Resources Management in 1965.

ii. Chippawa Creek Conservation Area – Pike Spawning Area

In the Chippawa Creek Conservation Area there is a section, part of an old oxbow of the Welland River, which could be the best possible spawning area for pike in the region. At present pike spawn there extensively, but the eggs are left high and dry when the level of the spring freshet on the Welland River drops rapidly. To remedy this condition several courses of action are needed.

Firstly, water from the Welland River must be kept in the part of the oxbow used by spawning pike long after the level of the Welland River has dropped below its spring levels.

Secondly, since there are carp in the Welland River, large carp must be prevented from entering the spawning area. Carp would uproot the vegetation and disturb and eat the freshly deposited eggs of pike.

Thirdly, in order to allow the young pike to try to gain access to the Welland River and not be caught in pools in the vegetation when the water level drops, a shallow channel is needed along the spawning areas, with several additional side channels at the same depth, so that there will be every possible opportunity for the fry to get into the river system.

A low earth dike at the narrowest point in the spawning area near its outlet to the Welland River can be bulldozed. This requires that a rough topographic survey of the sides of the spawning area and the narrow entrance channel must be made. The dike can be repaired with an hour or two of work with a bulldozer each fall, if necessary. There should be little erosion of the dike, as the velocity of the water entering and leaving the spawning area will be minimal. The sides and top of the dike can be seeded with Reed Canary Grass and Brome Grass.

Because evaporation will lower the level of the spawning bed below the top of the dike, a corrugated iron pipe must be placed through the bottom of the dike, with the lower end well below the surface of the Welland River. This pipe would have its upper end closed up when pike have entered the spawning area in the spring. The pond should be gradually drained through this pipe when the pike fry are a month or so old and the fry should pass through the pipe into the Welland River.

Large carp can be prevented from entering the spawning area by the installation of two or more baffles each about eight feet long, above the dike at the entrance to the spawning ground. The baffles would have numerous three-inch vertical gaps. Three- to six-year-old pike could get through these gaps. Pike of these ages can spawn, and have a body width of approximately 10 per cent of their total length. Thus a 28-inch pike will have a body width of only 2.8 inches. Three-inch gaps will certainly screen out large carp. The baffles would be put in place against three or more iron or wood posts driven into the dike. They should overlap, and they should be dropped into place as soon as the ice has gone out of the river and pond. Pike are looking for spawning areas at this time, while carp do not actually spawn until much later.

The advantage of having the baffle gates removable is, of course, that they would not be damaged by ice. The actual operation of the baffle gates would have to be



A section of the Chippawa Creek Conservation Area would be the best spawning area for pike in the region. A dike is needed at the above site to maintain enough water for the spawning pike.

arranged according to experience since, although pike spawn immediately after the break-up of the ice, the exact date of break-up varies from year to year.

Since a single 15-inch female pike will produce about 7,500 eggs, and a 25- to 28-inch pike about 60,000 eggs, there should be no lack of young fry.

Any spaces between the baffles and the dike or between the baffles and the sides of the entrance could easily be filled with chicken wire.

iii. *Wainfleet Township Quarry*

It is recommended that the quarry ponds in Lot 3, Conc. I of Wainfleet Township be acquired and developed for public fishing for smallmouth bass. Forage fish are already present.

b. *Wildlife Areas*

i. *Mud Lake Waterfowl Area*

This area includes parts of Lots 27 and 28, Concession IV in the former Township of Humberstone. At the time of writing, this site was being considered for waterfowl management by the Department of Lands and Forests.

Originally constructed as a dump site for canal dredgings, this area is enclosed to the north, west and south by an earth-fill dike. The water source is runoff and perhaps, in the spring, water from a ditch on the western side through a culvert and therefore the water area fluctuates seasonally. High water levels inundate the western portion of the site during maximum runoff, but the water area decreases appreciably during the summer. Water outlets occur through the culvert under the west dike and also over a low spot at the east end of the south dike. Water seems to escape only during periods of high rainfall through these outlets. Clay soils prevent appreciable seepage.

Dense stands of cattail are present around the water area and are generally too thick for extensive waterfowl use. Submerged aquatics such as milfoil and pondweed occur irregularly at low to moderate densities. Upland sites on the eastern half of the area are occupied by poplar, willow, dogwood and wet meadows.

An on-site examination in October revealed the presence of several green-winged teal, mallards and shorebirds utilizing the exposed mudflats. Four broods of mallards were raised in the summer of 1970. Muskrat could be more common if water levels were stabilized.

Comprehensive management would include diking areas of water outflow to the south and through the culvert. In order to create shallow water areas for puddle ducks, a low earth dike could be placed in a north-south direction to divide the east from the west half. Supplementary water could be supplied by a shallow lift pump from the Welland Canal. The addition of waterlevel control structures to the outlet locations is necessary to enable manipulation of the vegetation.

ii. *Escarpment Areas Adjoining Grimsby-Lincoln Town Line*

This is an area which should be considered in the long-term acquisition plans of the Conservation Authority. The area includes parts of Lots 21 to 23, Concession II and III in the former Township of Clinton, and parts of Lots B, 1 and 2, Concession II and Lots C, 1 and 2, Concession III in the former Township of North Grimsby. The area involved is shown on an accompanying map and the sections referred to in the following discussion are marked on the map.

Area A along the escarpment has good tree cover above the escarpment, mostly maple, but very little undergrowth. It is therefore not a particularly good area for wildlife. However, there is a pond below the escarpment which has good cover around the edges, including willow, sumac, dogwood, hawthorn, wild grape and apple trees.

The aquatic vegetation in the pond includes:

<i>Juncus sp.</i>	Density 1
<i>Lemna minor</i>	Density 3 at one end
<i>Chara</i>	Density 2
<i>Typha</i>	Density 1

The water is brownish and its depth varies from 6 to 10 feet. The pond could be used by wild ducks, but none were seen on the date, August 25, when it was examined. A Great Blue Heron and a Green Heron were seen, indicating that there must be at least minnows in the pond.

Area B contains maple, beech and oak with some undergrowth and is suitable habitat for ruffed grouse, rabbits, squirrels, chipmunks and songbirds.

Area C, along the river bottom, contains dense cover, such as raspberry, sumac, grape, nightshade, elderberry, apple, jewelweed and hawthorn.

Area D is dry scrub providing good cover.

Area E contains little cover for wildlife.

Area F, including birch and maple, has very little cover. It is recommended that if any attempt is to be made to acquire lands in this general section of the escarpment, the priority, so far as wildlife and vegetation are concerned, should go to two areas. One is the section of Area A above the escarpment, south of the pond, and the pond itself. The second recommended area includes the valley of Thirty Mile Creek (Areas B and C).

Shrub plantings for wildlife could be made along the southern edge of the western area recommended above. They are hardly needed in the eastern area. The Bruce Trail passes through both areas and, because the area above the escarpment is so narrow, it is questionable that hunting should be permitted in it.

iii. Long Beach Conservation Area Lagoon System

It is recommended that the Authority construct a large lagoon north and north-west of the existing lagoon at the Long Beach Conservation Area. This should include artificial islands if at all possible, as these are almost essential for nesting waterfowl. The present lagoon appears to be overloaded and an additional lagoon is needed to reduce the overload at times of peak requirements. As the area is so close to the heavily used part of the Conservation Area, it should be considered a refuge and no hunting allowed in it.

iv. Saltfleet Township Quarry

There is an abandoned quarry in Lot 4 Concession V of Saltfleet Township. An accompanying map shows the area with some of the features in detail. This area is at present owned by the Township of Saltfleet.

The area was examined on August 17, 1970. There were two ponds, both marked No. 1 on the map as they must at times be one pond, but when examined they were separated by a grassy flat area. Vegetation found around these pools included *Scirpus*, *Juncus*, grasses, red osier dogwood, hawthorn, wild apple and honey locust. In the water the chief vegetation was *Chara*, other green algae, and *Sagittaria*. On the larger pond there were several large floating masses of algae.

Birds seen on or around these two ponds included the following:

Mallards, approximately	70
Blue-winged Teal	8
Greater Yellow-legs	4
Solitary Sandpiper	4

The maximum depth in these two pools was about three feet.

The pond marked on the map as No. 2 is also shallow and a ditch from it runs out of the north end of the quarry. The vegetation in and around this pond included those species already mentioned for Pond No. 1, and in addition wild grape, raspberry, willow and nightshade (*Solanum Dulcamara*). Large numbers of Killdeer were near here. This pond is too small and too shallow at present to be of much use to wildfowl. A possible solution would be to dam the ditch where it leaves the quarry. This would probably also raise the level of the water in the larger pond and increase its surface area.

Area No. 3 on the map is a part of the quarry floor which is not flooded. This could be flooded if the water level was raised about three feet.

The area marked No. 4 contains scrubby hawthorn, sumac, and honey locust. There is relatively little cover around the ponds, but this did not seem to disturb the waterfowl which were there.

The quarry area could easily be acquired by the Conservation Authority and managed either for hunting or as a wildfowl refuge. The building of a very small dam and the introduction of cover plants around the edges would considerably increase the capacity of this area to harbour nesting waterfowl. The Township of Saltfleet now rents the land to a farmer for pasture for cattle.

If the land is *lightly* grazed, there should be little harmful results to the breeding of such species as Mallards. However the land should not be *heavily* grazed. It is, therefore, recommended that a fence could be put across the lot below the damsite and on the south side of the ditched portion of Forty Mile Creek.

It is also recommended that advice be sought from the Wildlife Extension Service of the Department of Lands and Forests (from the Aylmer District Office) before any changes are made in ownership or improvements. However, there should certainly be some Pondweeds introduced into the ponds.

v. *Escarpment Area South-west of Grimsby*

It is recommended elsewhere in this report that a large area above and below the Niagara Escarpment south and west of Grimsby be acquired, as and when funds permit. A small part of this area (called the Beamer Falls Conservation Area) has already been acquired by the Conservation Authority, as shown on the accompanying map. Acquisition of the remaining area appears to be a long-term project.

There are good possibilities for maintaining or improving the whole area for wildlife. The actual habitat on the various parts of the area, as numbered on the accompanying map, is described in the field notes of the survey, available to the Authority.

However, Area No. 6, which is the main body of woodlands above and below the escarpment, merits special mention. This has good tree cover of oak, birch and maple, and within it patches of dogwood, grape and chokecherry, all of which provide food for wildlife. The undergrowth and cover are fair. It is an area already suitable for grouse and rabbits.

The question of hunting in an area as large as this inevitably arises. The Bruce Trail follows the edge of the escarpment, and as this trail is very heavily used at all times of the year, hunting should not be permitted within 100 yards of the trail.

Whether the area is acquired for the public or not, there is a possibility of developing the area, less that strip very close to the Bruce Trail, for public hunting. This could be carried out with the co-operation and advice of the Wildlife Extension Service of the Department of Lands and Forests. The local angling and hunting clubs could be expected to co-operate by posting as "Prohibited Zone" any areas around houses or near the Bruce Trail where hunting should not be allowed. The local hunting clubs could also acquire shrubs for wildlife from the Department of Lands and Forests

and carry out the planting of these with expert advice from the Wildlife Extension Service.

The proposed area suitable for hunting, as shown on the accompanying map, could easily be enlarged to make a self-perpetuating hunting area by the inclusion of considerable land south of Regional Highway 79, if the owners can be persuaded to participate in the plan. There is a considerable area of woodland in this additional area.

vi. *Additions to St. Johns Conservation Area*

The lands surrounding the St. Johns Conservation Area (with the exception of some bottom land used for truck gardening) are in exceptionally good condition for wildlife. Lots 1 to 5, Concession V, Pelham Township, include an area (of mixed woods with many useful shrubs) which is recommended for consideration for eventual acquisition in the Conservation Authority's long-term plans. Lands farther north have been considered for similar purposes by another department of the provincial government. These lands are in what is known as the Shorthills Area.

There is another area which at one point adjoins the St. Johns Conservation Area, and which might be even more profitable to acquire, principally for wildlife and in part for forestry. This area, as shown on an accompanying map, includes parts of Lots 154, and 155 and 156 in Thorold Township. The area includes three cold, clear trout streams and there is a possible damsite at the northern or downstream edge of the property, and the dam would make a satisfactory trout pond. There are several good trails across the area, which has a great variety of tree and shrub species and a number of small clearings. The area at present supports pheasants, ruffed grouse, cottontails and squirrels. The area could be managed for wildlife, with three or four brush piles per acre for cottontails. Corn could be grown for pheasants along the eastern and southern boundaries and with this improvement additional pheasants could be introduced. The Fonthill town dump lies at the south-eastern edge of the area, and dumping here should be properly controlled.

The question of whether this property could be opened for hunting in season is one for the Authority to consider. The Authority should keep in mind that opportunities for hunting are becoming fewer and fewer in the Niagara region. The area is separated from the St. Johns Conservation Area by a road and many truck gardens. If hunting is to be allowed in the area, the Wildlife Extension Service of the Department of Lands and Forests should be consulted and various shrubs useful for wildlife food and cover should be planted.

vii. *Lyons Creek Area*

It is recommended that the exceptional cover and food for wildfowl in the area of Lyons Creek (in Lots 1 to 7, Concession IV, former Crowland Township) be retained, and if it becomes possible to acquire any of the bottom land and creek, this should be done. It is recommended that an arrangement be made with the St. Lawrence Seaway Authority that in order to retain the food and cover plants, not less than 10 c.f.s. nor more than 20 c.f.s. of water should be passed into the creek from the new portion of the Welland Canal.

Whether hunting is to be allowed in this area would depend on the ownership of the land and advice from the Department of Lands and Forests' District Biologist in view of the close proximity of the houses on the Cooks Mills Road. In any case, Wood Duck nesting structures should be erected here. The backwaters should still have plenty of *Lemna* and *Spirodela* (Duckweed), so essential to young Wood Ducks.

An accompanying map shows the area concerned.

PART OF TOWN OF GRIMSBY SHOWING AREA RECOMMENDED FOR PURCHASE

LEGEND





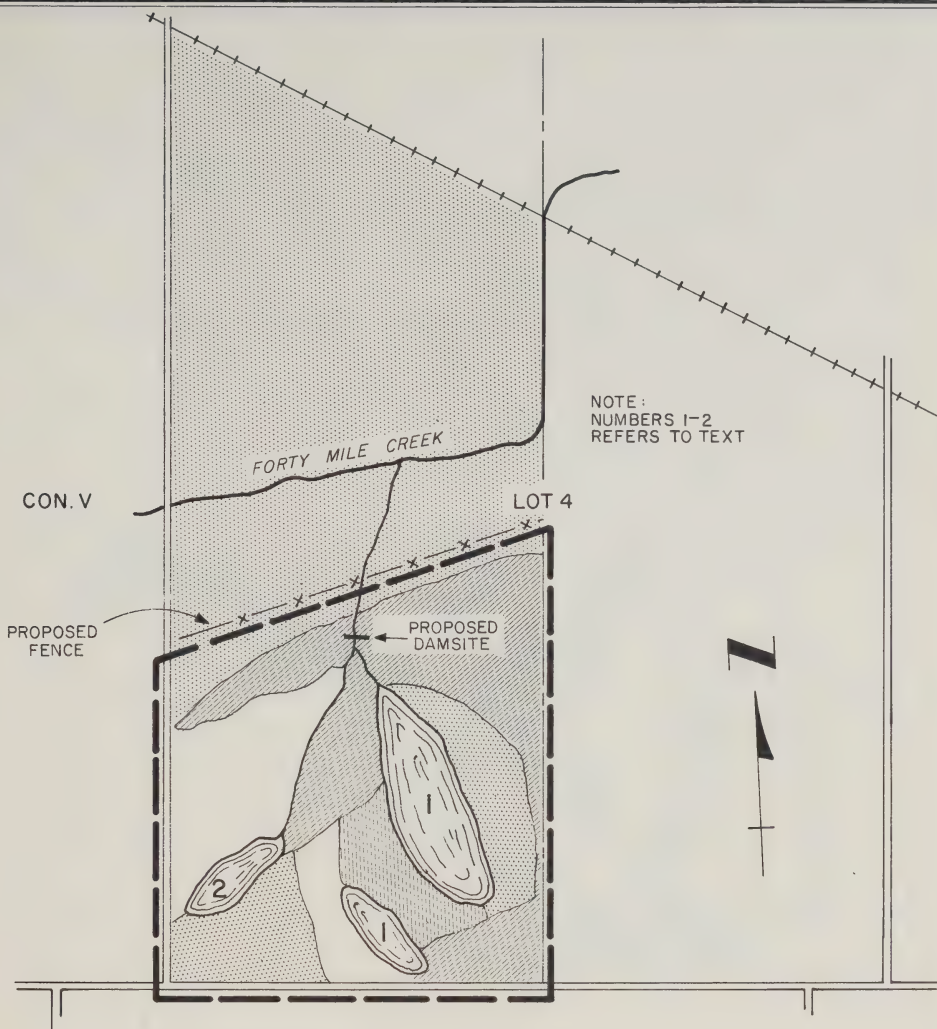
BEAMER MEMORIAL CONSERVATION AREA	-----	
PROPOSED ENLARGMENT OF CONSERVATION AREA	-----	
RECOMMENDED PUBLIC HUNTING AREA	-----	
WOODLAND	-----	




FIG. 21-A4

NOTE: NUMBERS 1 TO 8 INDICATE TYPE OF WOODLAND.
(SEE TEXT)



QUARRY IN SALT FLEET TWP.

LEGEND

 SCRUB

 PASTURE

 WET GRASS FLAT

 RECOMMENDED FOR ACQUISITION

500 250 0 500
SCALE  FEET

FIG. 21 - A5



AREA ADJOINING GRIMSBY - LINCOLN TOWN LINE

LEGEND

- WOODLAND
- AREAS FOR PRIORITY RECOMMENDED BY BIOLOGY SECTION OF C.A.B.
- AREA PROPOSED BY N.P.C.A FOR FUTURE ACQUISITION
- ROUTE OF BRUCE TRAIL
- A, B, C, etc. REFER TO TEXT

SCALE
1/4
0
1/4
1/2
 MILES

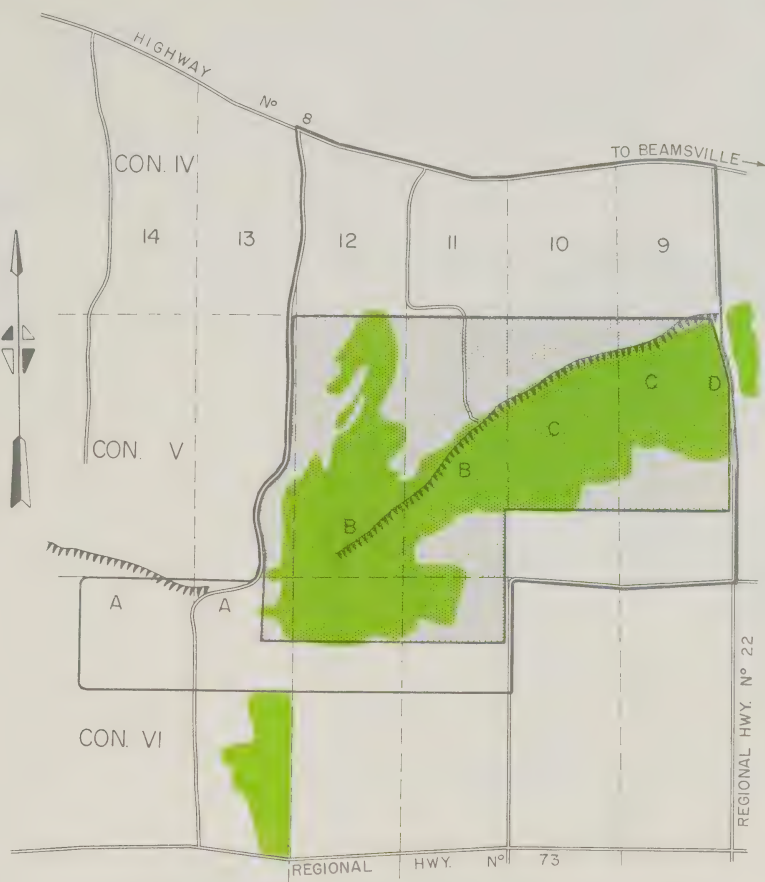
FIG. 21-A6



FIG. 21-A7






FIG. 21-A7



AREA PROPOSED FOR ACQUISITION IN THE TOWNSHIP OF LINCOLN

(FORMERLY CLINTON TOWNSHIP)

LEGEND

- WOODLAND----- 
- AREA PROPOSED BY N.P.C.A. FOR FUTURE ACQUISITION----- 
- AREA FOR PRIORITY RECOMMENDED BY BIOLOGY SECTION C.A.B.--- 
- A, B, C, D, REFER TO TEXT

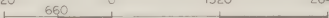




SCALE  FEET

FIG. 21-A8

AREAS ADJOINING
FIFTEEN AND SIXTEEN MILE CREEKS
TOWN OF LINCOLN
(FORMERLY LOUTH TOWNSHIP)

LEGEND

- | | |
|--|---|
|  | WOODLAND |
|  | ESCARPMENT |
|  | AREA PROPOSED BY N.P.C.A. FOR FUTURE ACQUISITION |
|  | AREA FOR PRIORITY, RECOMMENDED BY BIOLOGY SECTION C.A.B |
| A, B, C, D, E, & 2, 3 | REFERS TO TEXT |


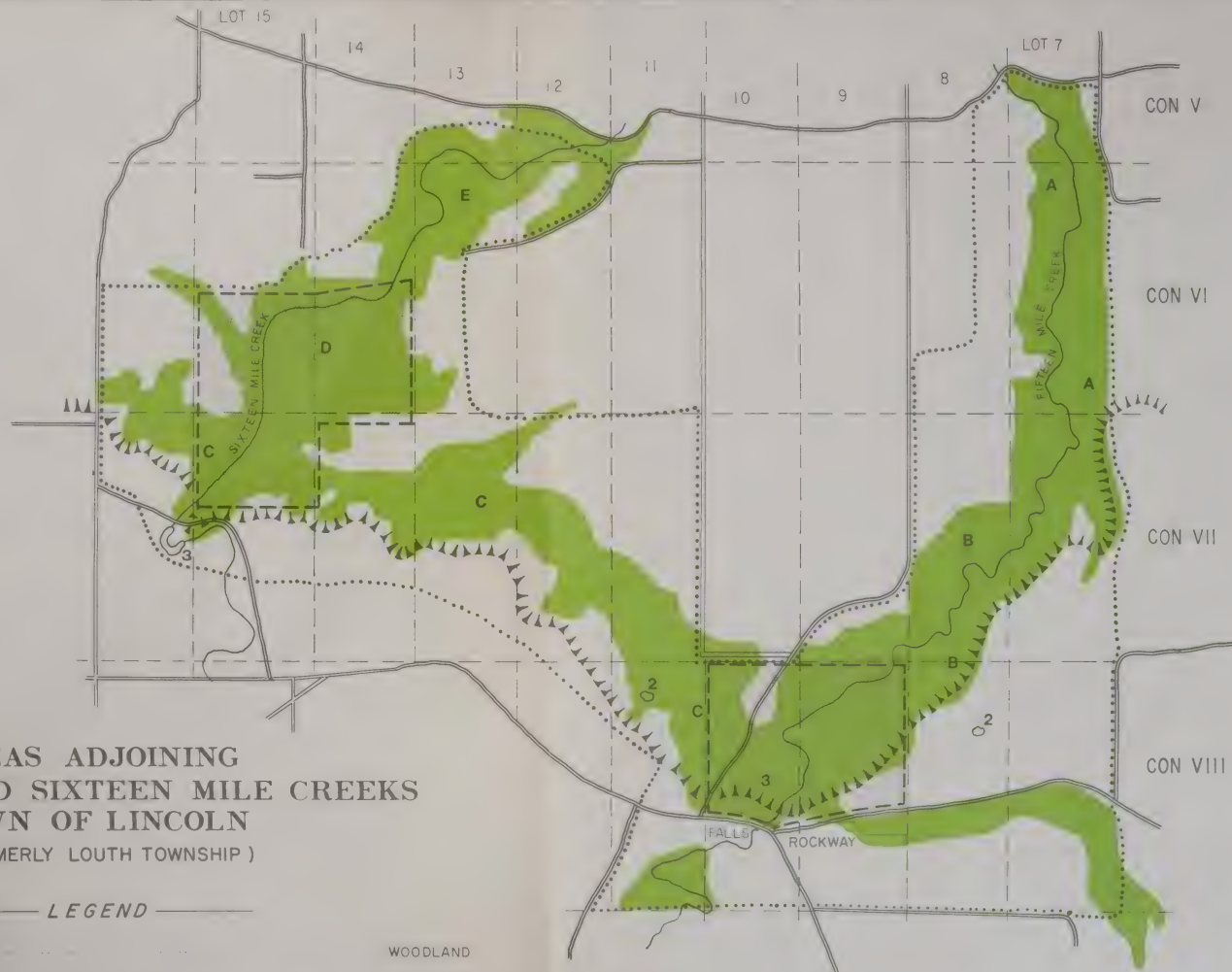
SCALE  MILES

FIG. 21-A9



viii. Warden Woods

It is recommended that the area known as the Warden Woods, south of Caistor Corners, now owned by the Conservation Authority, be enlarged by further acquisitions by the Conservation Authority. The present acquisition is only a very small fraction of the whole area of woodlands known as the Caistor Block, which harbours many deer, ruffed grouse and other wildlife.

ix. Escarpment Area Town of Clinton

This area, parts of Lots 9 to 14, Concessions IV to VI, in the former Clinton Township, now the Town of Lincoln, has been recommended for acquisition as part of the long-term plans of the Niagara Region Conservation Authority. A detailed account of the various sections as marked on the accompanying map is included in the field notes of the Conservation Authorities Branch, and is available to the Authority.

The part of this area recommended for priority in acquisition for wildlife management lies chiefly in Concession V Lots 9 to 12, with a small addition in Concession VI, as shown on the map. This includes an important part of the Niagara Escarpment and the woodlands above and below it. The section recommended includes a maple-beech woodlot, and also includes much dense shrub cover, consisting of sumac, raspberry, hawthorn and dogwood. The section is used by deer, ruffed grouse and cottontails.

If hunting is allowed in the area, some arrangement should be made so that those people using the Bruce Trail are not disturbed.

x. Area on Fifteen and Sixteen Mile Creeks

This area, shown on an accompanying map, has been separated into various sections. The descriptions of these sections are in the field notes, which are available to the Conservation Authority, which may be interested in acquiring the whole area for public use.

From this very large area two blocks of land are recommended for priority in acquisition from the biological point of view. These are outlined on the accompanying map. One has Rockway Falls within its southern boundary, and thus includes part of the Niagara Escarpment. This area, besides containing many beech, maple and oak trees, includes much excellent ruffed grouse cover.

The second block of land recommended for immediate acquisition is a part of the Sixteen Mile Creek valley and the surrounding land. This includes a large woodlot of which the main tree species is beech. However, there is considerable undergrowth, and good habitat for ruffed grouse and cottontails. Deer tracks were seen in this area.

xi. Point Abino Dune and Woodland Complex

It is recommended that the Conservation Authority take note of the rare association of plants in the dune and woodland complex on Point Abino on Lake Erie. This area is now surrounded by cottages and belongs to an American club. It should be drawn to the attention of the owners that this area has a rare floral complex and should be protected.

10. Recreational Development

Classification of Recreational Lands

At the more detailed level of systems planning, it is recommended that the Authority adopt a classification of conservation areas which will assist in the planning and management of its proposed open space system.

The classification is essentially a use-zone categorization and can apply to either a conservation area, or sub-zones of a conservation area.

The main classes could be as follows:

Class I Natural Area

These lands should have a minimum of development and may include: "wilderness" zones, valley flood lands, game sanctuaries, nature preserves (biotic or geomorphic), or natural streams.

The activities permitted in these areas would be: hiking, viewing, canoeing, horseback riding, back pack camping, nature study and cross-country skiing.

A natural area could assume a corridor pattern and could include land under only partial or easement control by the Authority.

Class II Intensive Specific-Use Areas

This class includes those activities which place considerable stress on the natural landscape such as picnicking, swimming, fishing, scenic lookouts, water access points, skiing areas, family and group camping, heavily used nature trails and/or interpretive sites, rock collecting areas, sledding and/or tobogganing areas, snowmobile areas or trails and motorbike areas or trails. Preferably, these areas would be owned by the Authority.

Class III Extensive Specific-Use Areas

These uses would be most suitable in single-purpose conservation areas, but might also be accommodated as a sub-use zone in a larger multiple-use area, with the exception of hunting during appropriate seasons.

Uses include: archery, rock climbing, hiking, bicycling, cross-country skiing and hunting.

Permanent facilities in this class area would be allowed which is not the case for Class I areas. Occasionally this would be the only difference between the two classes.

Class IV Historic Area – Cultural and Natural

These may be sub-zones of a larger area. However, if structures are involved, they often become the focal point of the conservation area in which they are located, thus becoming a Class II area.

Possible attributes for this type of area include blockhouses, lighthouses, sawmills, grist mills, cheese factories, pioneer farms or buildings, sites of significant historic events, historic roads or waterways, canals and archeological sites.

Class V Multiple-Use Areas

This category would conform most closely to the concept of conservation areas as recognized to date. A multiple-use area would probably include several sub-use zones and hence could permit any combination of uses included in Classes I to IV.

Class VI Service Areas

This zone will be necessary only in intensively used areas. It will include service concessions such as refreshment booths, information, supplies, washroom facilities, changehouses, first aid posts, boat rentals and marinas.

Although the lines separating classes of use zones are sometimes obscure, such a scheme gives the Authority a tool to facilitate management of conservation areas.

In proposing this system of parks and facilities, one is in fact considering a regional subsystem which is an integral part of the provincial recreation system. The purpose is to provide the widest range of opportunities for recreation as possible, while minimizing the impact of such developments upon the natural landscape.

Due to the decrease in the amount of suitable land available for outdoor recreation caused by burgeoning towns and cities, escalating land values, the development of private facilities such as homes and cottages, as well as the growing leisure time expenditure, it is improbable that the Authority will ever have excessive land for recreation development. Pressure from lack of land is already being felt in the Niagara Authority. Because of budget

restrictions and varied allocations, and the limited amount of land the Authority can afford to purchase outright, there are a number of alternatives which should be investigated and utilized where possible. Some of these alternatives are:

1. the use of easements for limited control, various types of trails, and buffer zones around Conservation Areas;
2. cluster-zoning for cottage and rural housing development;
3. open space zoning;
4. obtaining commitments for sale from owners, to be exercised at such time as the land is disposed of;
5. lease-back arrangements with former owners;
6. buying land "on time", i.e., a portion of the whole parcel every year;
7. solicitation of gifts of land, making use of the "foundation" principle.

Once a piece of land is acquired, there is pressure to develop it immediately. However, premature development without proper planning may lead to over-use or misuse. Specialized uses such as swimming beaches, scenic lookouts and rare biotic communities cannot be regenerated if they deteriorate through misuse of a basically non-renewable resource. Some intensive uses such as picnicking and camping may be possible on alternative sites.

Since the more attractive and/or unusual sites are likely to be the first to come under conservation control, serious thought should be given early to each and every planned development to ensure that long-range goals are not sacrificed for short-range utility.

In advance of development, design standards should be formulated which will be symbolic of the Authority. Structural materials should be vandal-proof, but of high quality and should blend well with the natural landscape. The services of professional architects and landscape architects should be sought in preparing these plans of development.

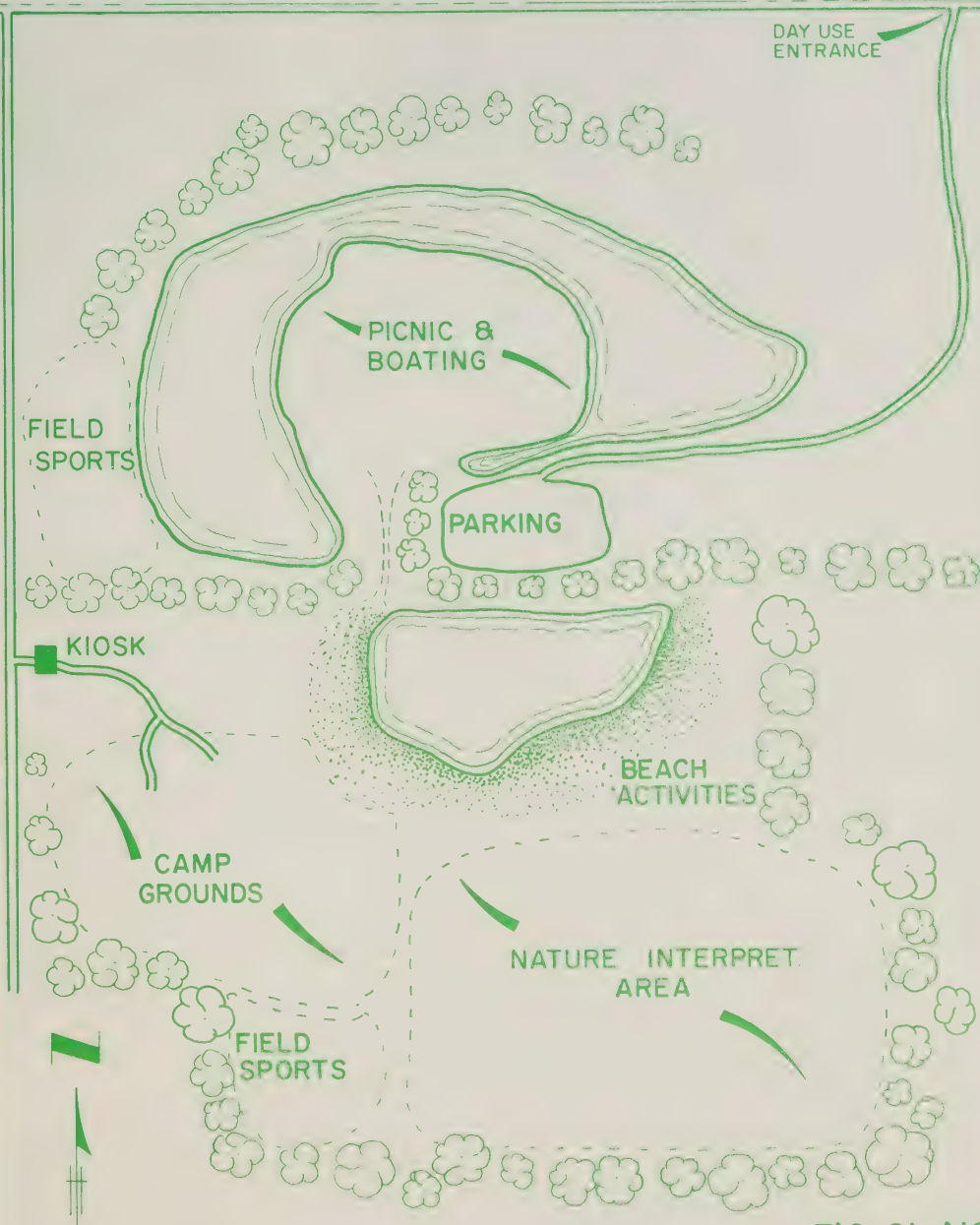


FIG. 21-A10

PORT COLBORNE QUARRY CONCEPTUAL DEVELOPMENT PLAN

NOT TO SCALE

